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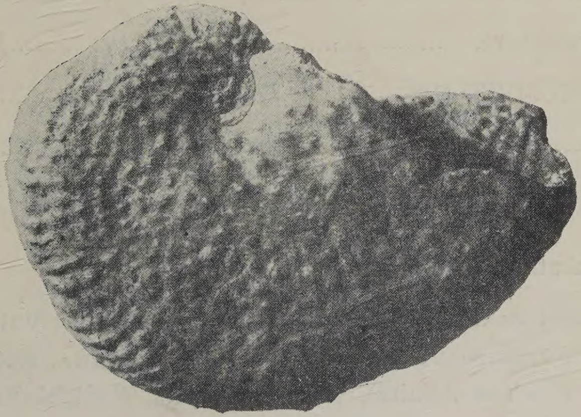

日本古生物學會
Palaeontological Society of Japan
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324. AN *ATURIA* FROM (?) KUSU COUNTY, OITA PREFECTURE, KYUSHU*

TEIICHI KOBAYASHI

Geological Institute, University of Tokyo.

大分県玖珠郡（?）産の *Aturia*：　これは嘗って帝室博物館に保存されていた標本で，その産地には疑問があるが，*Aturia minoensis* var. と称す可きものである。そしてこれには体房や殻の表面の様子などが残っている。特にその中央縦断面から内部構造や化石化過程などについて興味ある観察が出来る。

小　林　貞　一

The specimen described here is kept in the Tokyo Science Museum. I examined it in making a median longitudinal section. For the courtesy of having this opportunity I am grateful to Mr. Hiroshi Ozaki of the museum.

The label attached to the specimen is read "Kusu-gun, Oita prefecture." Therefore this must be the specimen of which Yabe (1904, p. 108) stated that "There is an *Aturia* specimen from Prov. Bungo (i. e. Oita Pref.) in the Imperial Museum (the progenitor of the Science Museum)." It is, however, a question whether it was actually unearthed from Kusu-gun, because no marine Miocene or older Tertiary sediment is known in this area (Shuto, 1953). Nevertheless it is a well preserved specimen worthwhile to described.

In Japan there are four species of *Aturia* beside two unnamed ones both of which having unusually broad subtriangular whorls (Kobayashi, 1956, 57). Therefore there is no risk of confusion for the present specimen with these two. The distinction is figured out here for the other four with reference to the septal aspects.

The present specimen agrees best with *A. minoensis* not only in the septal features but also in the whorl section and growth of the spire. There are, however, some differences. In the specimen the antero-lateral projection of the ventral saddle is less significant than in *A. minoensis* s. str., while the ventro-lateral lobe forms a more distinct sigmoid with the lateral saddle. With regard to this difference it may be said that this is *Aturia stansburiensis* Glas-

Key to the Japanese Species of Aturia

A	Ventro-lateral lobe invaginated into the preceding	*Aturia nagaoi* (Eocene)
	Ventro-lateral lobe not invaginated into the preceding	B
B	Septal interval wide	*Aturia yokoyamai* (Oligocene)
	Septal interval narrow	C
C	Ventral saddle narrow; ventro-lateral lobe pointed at the end	*Aturia minoensis* (Miocene)
	Ventral saddle broad; ventro-lateral lobe rounded at the end	*Aturia tokunagai* (Miocene)

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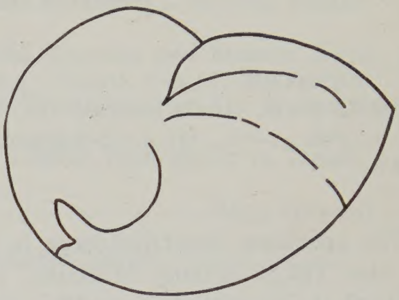
* Received Sept. 13, 1956; read at the 64th Meeting of the Palaeontological Society of Japan, Oct. 6, 1956, at Kyoto.

SNER (1955), if *A. minoensis* were *A. australis* M'COY (TEICHERT, 1944). For the time being, however, it is called *Aturia minoensis* var. and no variety name given because of the uncertainty of its locality.

It is then, interesting to see in this specimen some of the features which were unknown of the species. The shell is about 115 mm. in diameter and about 50 mm. in thickness. The body whorl extends more than a quarter of a volution from the last septum. The shell is rather strongly distorted in this part, but insofar as I can judge, its original whorl section is not much different from that of the holotype of *A. minoensis*. Growth striae are fairly well impressed on the specimen. They are strongly convex forward, almost semicircular, somewhat more broadly rounded on the umbilical side than the other and sinuated on the ventral periphery.

SHIMIZU (1926) said of *Aturia tokunagai* " body chamber occupying 2/3 of the last volution." It is also stated by MILLER (1947, p. 77) for *Aturia* as a genus that " the living chamber is known to extend the shell at least half a volution." In the holotype of *Aturia grangei* FLEMING (1945) which is a complete shell, however, the chamber appears shorter than half a volution. Just how long the chamber of *A. minoensis* var. is, is unfortunately unknown, because the aperture is unpreserved.

There are various kinds in the preservation of internal structure. In *A. yokoyamai* from the Poronai shale (KOBAYASHI, 1957), for example, the original structure is well preserved in the last volution which is filled up with dirt, while it is partly destroyed in the inner volutions by crystallization. In *A. tokunagai* from Hidachi (SHIMIZU, 1926) as well as *A. panamensis* from Los Santos, Panama (MILLER, 1947, pl. 79, fig. 3) the whole space of the spires appears to be occupied by crystalline calcite, but the septa escaped from crystallization.



Text-figure
Aturia grangei FLEMING. ×1/2

Because the mode of preservation is an interesting subject, the median longitudinal section is made and polished. In the specimen of *A. minoensis* var. the body whorl and siphuncle are filled with very fine sandy matrix, but the camerae with calcite. The sharp difference of the filling between the siphuncle and camerae must depend upon the imperforate wall between the two parts of the phragmacone which is made of invaginated septal funnels and endosipholinings. Closed by such a wall perfectly, calcareous material in the chambers has crystallized independently from the empty siphuncle. Later on, sandy matrix was injected into the siphuncle through the body chamber. In the course of injection the siphuncular wall happened to be destroyed. Such a damage is seen at the fourth camera counted from the adoral side.

The siphuncle is dorsal, marginal and nearly as large as one-fifth the whorl height. Incidentally, a reexamination on the holotype and other specimens of *A. minoensis* has shown that its siphuncle is also marginal and about the same in size.

Because little is known of the inner volutions of *Aturia*-shells, measurements are made on the polished section and the results tabulated below:

Volution	Diameter in mm.	Major radius in mm.	Whorl height on the radius	Number	
				Camerae	Septa
Last	102	65	21	14	15
Last but one	34	44	12	12.5	13
Last but two	14	12	6	10.5	11

In the growth stage of 26 mm. in diameter 11 camerae and 12 septa or 12 1/3 camerae and 13 septa are countable on the last volution respectively of *A. tokunagai* or *A. minoensis* var. In other words, the septa are more crowded in the latter than in the former. Likewise, the septa are denser in *A. minoensis* var. than in *A. panamensis* in which the latter 12 septa and 11.5 camerae or 10 septa and 10 camerae are countable on the volution where the diameter of the shell measures 36 mm. or 14 mm. respectively.

Finally the comparison is made between *A. yokoyamai* and *A. minoensis* var. in the growth stage of 70 mm. and found that the septal interval is much broader in *A. yokoyamai* because in *A. yokoyamai* 6.5 camerae and 7 septa are found in a half of the last volution whereas 5.5 camerae and 6 septa exist in the same portion of *A. minoensis* var.

Unfortunately details of the internal structure are unpreserved in this sepcimen, but it is interesting to see that some septa-like fragments are contained in certain camerae. Judging from the duplication of a septa by a septa-like hyposeptal deposit in *A. yokoyamai* of which observation is described in my recent paper (1957), it is quite probable that they are detached pieces of such septa-like deposits.

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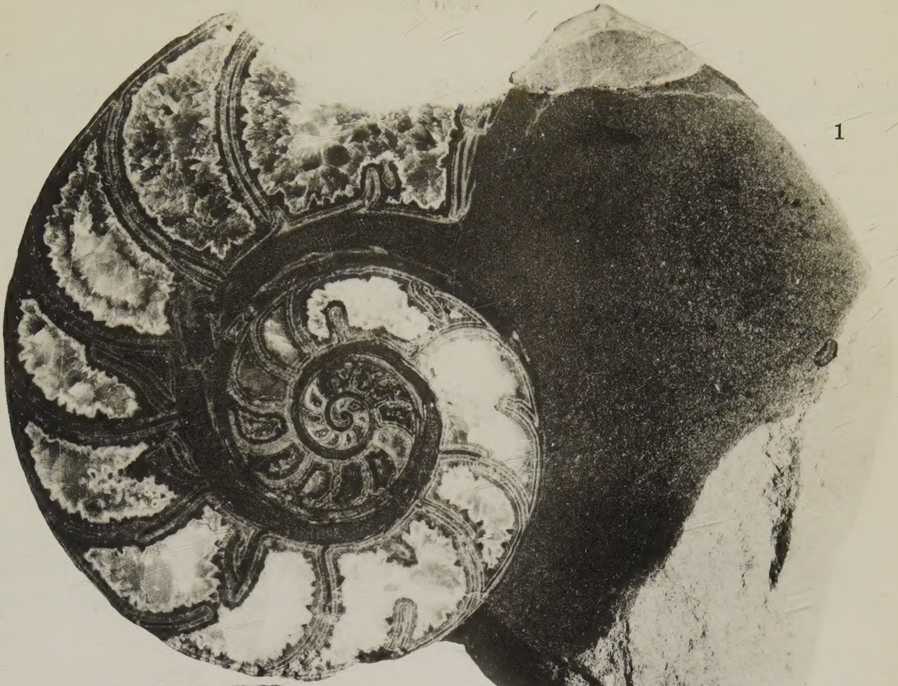
Explanation of Plate 19

Aturia minoensis KOBAYASHI, var.

Figure 1. Median longitudinal polished section.
Figure 2. Lateral view.
Figure 3. Ventral view.
All natural size.



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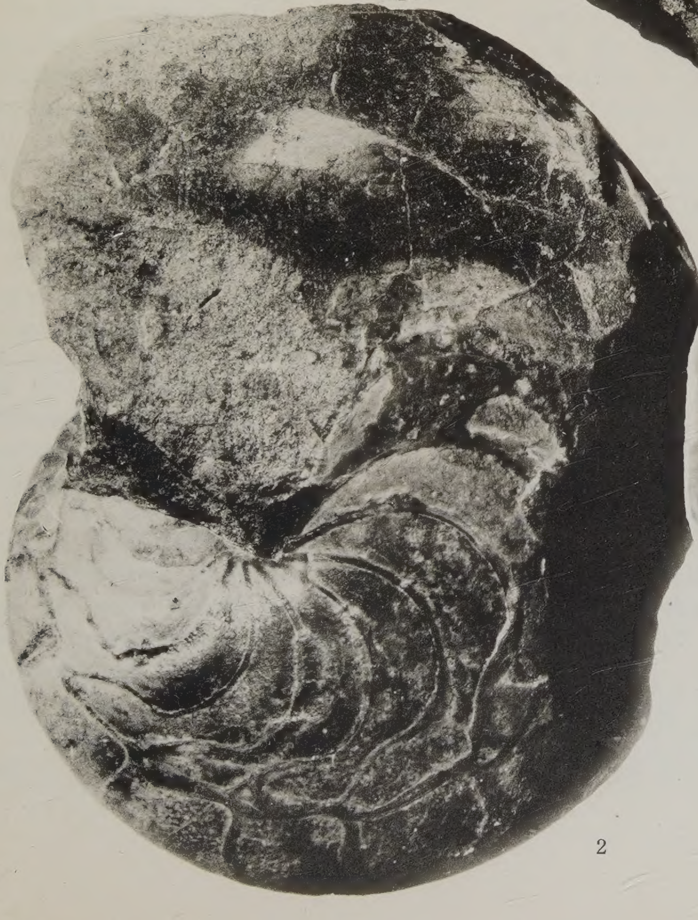

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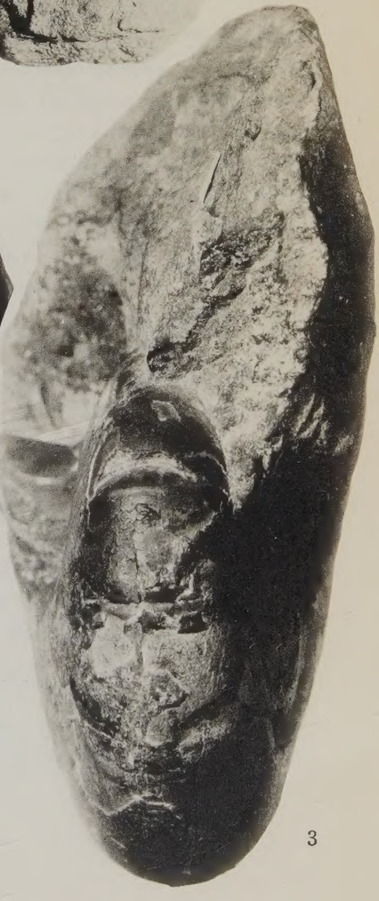

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325. "ONIMARU TYPE" CORALS NEWLY FOUND IN THE NORTHERN KITAKAMI MOUNTAIN REGION, JAPAN*

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Geological Survey of Japan

and

MAKOTO KATO

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北部北上山地において新発見の鬼丸型珊瑚： 北部北上山地における石炭系の存在につき述べ，釜石市内旧鵜住居村外山及旧甲子村上小川産の以下の珊瑚2種を記載した。*Siphonodendron pseudomartini* (Yabe et Hayasaka), *Hexaphyllia* sp.　　吉田　尚・加藤　誠

In 1950 M. Watanabe and M. Minato pointed out that there are two types of Palaeozoic formation in the Kitakami mountain region, N. E. Honshu, Japan. Of them, one type is represented by the relatively shallow sea facies, ranging from the Gotlandian to the uppermost Permian in age.

This type of Palaeozoic formation is very fossiliferous in every horizon, although the successions of the fossiliferous layers are occasionally interrupted by unconformities. This type of Palaeozoic formations is typically developed in the southern part of the Kitakami mountain region.

On the contrary, in the northern part of the Kitakami mountain region, there are Palaeozic formations, consisting of heavy bedded sandstone, shale, chert, limestone and schalstein, which are observed to be apparently conformable with each other without any sort of stratigraphical breaks.

In the second type, the Palaeozoic formation is almost barren of fossils, except that some Permian foraminiferal remains have been found in a few localities. Accordingly Y. Onuki and others held the belief that these older formations in the northern Kitakami mountain region may be exclusively Permian in formations.

Meanwhile, Dr. M. Minato once suggested from his tectonic point of view, that the most parts of these complexes should be not only Permian but also Carboniferous in age, if still older deposits are not contained in them.

The present senior author unexpectedly found some coral remains from the limestone belonging to such older complex of the second type, developing in the city of Kamaishi, Iwate Prefecture.

According to Minato, the corals now in problem are definitely of the Lower Carboniferous type, which are

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* Read June 20, 1956; received Jan. 10, 1957.

Siphonodendron and *Hexaphyllia*.

This is the first discovery of Lower Carboniferous fossils from the northern Kitakami mountain region. This may be by no means an unimportant fact from the stratigraphical point of view.

In offering this suggestion, Minato requested the writers to investigate these fossils more in detail. This short note deals with the result of this study.

The determined species are:

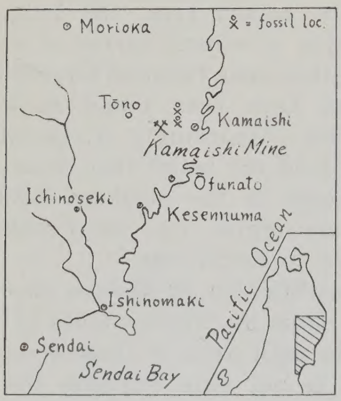
Siphonodendron pseudomartini (Yabe et Hayasaka)

Hexaphyllia sp.

Loc.: 2 km west of Sodeyama, Kamaishi City, Iwate Prefecture.

Siphonodendron pseudomartini (Yabe et Hayasaka)

Loc.: 1.4 km north of Kamiogawa, Kamaishi City, Iwate Prefecture.



Text-fig. 1. Map showing the localities.

Here the writers wish to describe these corals at the request of Prof. Minato, to whom they express their hearty thanks for his guidance throughout the course of this study.

Description of Species

Family Lithostrotiontidae Grabau, 1927

Genus *Siphonodendron* M'Coy, 1894

Siphonodendron pseudomartini (Yabe et Hayasaka)

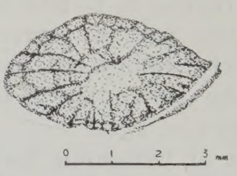
Text-fig. 2.

1915. *Lithostrotion pseudomartini*, Yabe et Hayasaka, pp. 128–130.
1943. *Siphonodendron pseudomartini*, Minato, p. 235, pl. 22, fig. 5.
1955. *Siphonodendron pseudomartini*, Minato, pp. 71, 72, pl. 3, fig. 1; pl. 4, fig. 9; pl. 31, fig. 7; text-fig. (6), figs. A, B, C, D.

Corallum compound, fasciculate, and composed of irregularly aggregated corallites, which are laterally compressed, 3 to 5 mm. in diameter.

Epitheca thin. Major septa numbering as many as 18 in mature stage, straight and thin; they do not reach the columella; their distal ends occasionally form a pseudo-innerwall together with the arching tabulae.

Columella is thin, sometimes disappearing in cross section, but it unites firmly with counter and cardinal septa, when it is developed.



Text-fig. 2. *Siphonodendron pseudomartini* (Yabe et Hayasaka), a cross section of younger corallite.

Minor septa very short. Dissepimentarium also very narrow. Dissepiments usually one, rarely two in rows, and are very small but regular in size. Clearly observable longitudinal sections not obtained, but judging from the tangential section, the arching of the tabulae may not be very strong.

Remarks:—It is far from doubtful that the present form is wholly conspecific with *Lithostrotion pseudomartini*

YABE et HAYASAKA.

This species is easily separable from its allied forms such as *Lithostrotion irregulare* var. *asiatica* YABE et HAYASAKA and *Siphonodendron pauciradiale* M'COY by the size of corallites, mode of aggregation, and by septal as well as dissepimental numbers.

U. H. Reg. nos.: 12447, 12448, 12449, 12450.

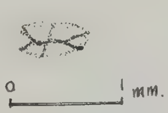
Family Heterophyllidae YABE et SUGIYAMA, 1940

Genus *Hexaphyllia* STUCKENBERG, 1904

Hexaphyllia sp. indet.

Text-fig. 3.

Only single cross section at hand. As is shown in text-fig. 3, the present form belongs to a species of the genus *Hexaphyllia*. It may with high probability represent a corallite of *Hexaphyllia japonica*, described by YABE and SUGIYAMA from the southern Kitakami mountain region, although the cross section of the present specimen shows a very early stage of ontogeny, and is obliquely cut.



Text-fig. 3. *Hexaphyllia* sp.

U. H. Reg. no.: 12448.

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Trans. Proc. Palaeont. Soc. Japan, N. S., No. 28, pp. 119–127, pl. 20, Dec. 15, 1957

326. LIASSIC *CHLAMYS*, "*CAMPTONECTES*" AND OTHER PECTINIDS FROM THE KURUMA GROUP IN CENTRAL JAPAN*

(Studies on the Liassic Pelecypods in Japan, 5)

ITARU HAYAMI

Geological Institute, University of Tokyo.

来馬層群産の *Chlamys*, "*Camptonectes*" その他の Pectinids：来馬層群には未記載の Pectinids のあることが知られているが、来馬統模式地附近および同統中下部の北又谷層、寺谷層、榀谷層の二枚貝化石を検討した結果 10 種（うち 4 種は新種）を識別したので岩室累層産の 1 種をこれに加えて記載した。

速 水 格

Triassic and Upper Jurassic scallops in Japan have been described by Kobayashi (1931), Matsushita (1937), Kobayashi and Ichikawa (1949), Kimura (1951), Nakazawa (1952), Ichikawa (1954a, 1954 b) and Amano (1955), but Liassic ones remain undescribed, although several pectinids were known to Kobayashi (1935) and Toriyama (1938) from the Kuruma and Toyora groups in the Inner Zone of Southwestern Japan. Lately the Kuruma and Toyora collections were greatly amplified by the writer. In the preceding paper he proposed *Radulonectites* as a new pectinid genus. The Toyora fauna, which will be discussed in near future, consists of so different species from the Kuruma one that the writer could find only a few pelecypod species common between these two groups, notwithstanding the fact that they are almost contemporaneous strata. On the other hand, the Liassic Shizukawa group in Northeastern Japan seems poor in fossil pectinids.

In this paper are described the following Kuruma species:—

Chlamys kurumensis
Kobayashi and Hayami, n. sp.
Chlamys cf. *kurumensis*
Kobayashi and Hayami
Chlamys kotakiensis
Takai and Hayami, n. sp.
Chlamys sp. indet.
"*Camptonectes*" *oishii*
Kobayashi and Hayami, n. sp.
"*Camptonectes*" *subflabelliformis*
Hayami, n. sp.
"*Camptonectes*" a sp. indet.
"*Camptonectes*" b sp. indet.
Eopecten (?) sp. indet.
Entolium sp. indet.
Variamussium (?) sp. indet.

Family **Pectinidae** Lamarck

Genus *Chlamys* Röding, 1798

Type species:—*Pecten islandicus* Müller (1776), Recent.

Chlamys kurumensis Kobayashi and Hayami, new species

Plate 20, Figures 1a–b.

Description:—Represented by two right

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* Received Jan. 12, 1957; read Feb. 9, 1957.

valves. Shell small, nearly acline, slightly inequilateral with some expanded anterior area, trigonally ovate in outline exclusive of auricles, weakly convex, higher than long (holotype, MM 2697; 16.0 mm. long; 17.5 mm. high); antero-dorsal margin of shell-body slightly concave; postero-dorsal one almost straight but slightly convex in umbonal region; apical angle between the two about 90 degrees, although it is slightly smaller in juvenile stage; hinge line long and straight; umbo scarcely rising above hinge-margin, located slightly posteriorly from mid-point of length; auricles clearly defined, very unequal; anterior one large, protruded forwards, supported by a developed byssal sulcus, forming a profound byssal notch below; ctenolium not seen, probably absent; posterior auricle comparatively small, triangular, subvertically truncated at the extremity; surface ornamented with about 42 radial costae which are flat-topped, wider than interspaces, increasing their number by somewhat irregular bifurcation; each auricle sculptured by about 4 radials in its ventral half; auricular sulcus marked with strong concentric lines; concentric lines of growth very dense, crossing both of costae and interspaces.

Observation and Comparison:—Only two right valves are at hand. The holotype specimen (Fig. 1a) is slightly broken at the posterior end, but the byssal area and radial ornamentation are well preserved. Judging from them, this species can be safely refered to *Chlamys*, although the internal structures are unknown.

This species appears fairly similar to *Chlamys mojsisovicsi* KOBAYASHI and ICHIKAWA (1949; NAKAZAWA, 1952), a well known Upper Triassic species in the Southwestern Japan, but differs from the typical specimens of that species from Sakawa basin in the larger apical angle and presence of radials on the byssal auricle, although the ornamentation of *mojsisovicsi* is seemingly fairly variable. Radial costae are also present on the byssal auricle of that species from the Sakuradani (ICHIKAWA, 1954a) and Mine area (undescribed)*, which may be more closely related to this than typical *mojsisovicsi* and ancestral to this. But the radials are more regular, stout and flattened on tops in this species, and, moreover, antero-dorsal margin of shell-body is fairly longer than in those forms.

Pecten dispar TERQUEM (1855) from the lower Lias in France is another related species in weak convexity of the right valve and irregular bifurcation of radial costae. In the French species, however, the byssal auricle is wholly sculptured with radial markings, while they are restricted to its ventral half in this species.

Occurrence:—Rare in a sandstone of the Kuruma group at Kamikawara in Kuruma, Kitaotari-mura, Nagano Prefecture (Province of Shinano).

Chlamys cf. *kurumensis*

KOBAYASHI and HAYAMI

Plate 20, Figures 2a–b.

There is a solitary specimen (MM 2699) whose auricular part is broken off. It may be a right valve, judging from the bifurcation of radial costae and weakness of shell-convexity.

Shell nearly equilateral, trigonally circular with height (42.5^+ mm.) more or less in excess of length (40.0 mm.); postero-dorsal margin of shell-body almost straight; apical angle 90 degrees or so; radial costae dense, about 65 in number, flat-topped, increasing their number by bifurcation, slightly curved outwards in lateral areas; their interspaces comparatively narrow, marked with dense concentric lines of growth.

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* TOKUYAMA's collection through his courtesy.

This resembles the preceding species in many respects and may be its adult form. But the radial costae are more numerous than in typical *kurumensis*, even though they bifurcate in the middle stage.

Occurrence:—Same as the preceding.

Chlamys kotakiensis

Takai and Hayami, new species

Plate 20, Figures 3–5.

Description:—Shell small to medium for genus, inequivalve, nearly equilateral in two valves exclusive of auricles, almost acline, moderately convex in left valve but rather weakly in right, more or less higher than long; antero-dorsal and postero-dorsal margins of shell-body nearly straight, forming an apical angle of about 90 degrees in each valve; hinge-margin straight; umbo scarcely protruded above hinge-margin, located near median point of length; right anterior auricle large, protruded, linguiform, supported by a developed byssal sulcus, forming a deep byssal notch below; other auricles triangular, rather ill-defined from shell-body, obtusely truncated at the extremities; surface marked with about 58 fine and dense radial costae, whose number is increased by insertion without difference in prominence in left valve; interspaces almost equal or slightly wider than costae; radials distributed also on auricles except for byssal one; numerous fine concentric lines of growth crossing costae and interspaces.

Measurement in mm.	Length	Height	Apical angle	Number of ribs
Holotype (MM 2700) Left valve	33.0	29.0	115°	58
Paratype (MM 2701) Right valve	31.0	33.0	90°	54+
(MM 2702) Left valve	15.5	21.5	80°	60

Observation and Comparison:—The holotype (Fig. 5) is more or less compressed secondarily in dorso-ventral direction, and the apical angle in consequently much larger than original. On the contrary another illustrated right valve (Fig. 4) is compressed antero-posteriorly. The auricles of left valve are ill-defined if compared with modern *Chlamys* (s. s.). This species, however, can be included in the wide sense of *Chlamys* by the developed byssal auricle, deep byssal notch and radial ornamentation.

This species is distinguishable from *Chlamys mojsisovicsi*, *C. textorius* (Schlotheim) (Quenstedt, 1858; Staesche, 1926; Dechaseaux, 1936) from the Lias in Europe and its offshoots from the Dogger and Malm by the ill-defined auricle of left valve and fine radial ornaments.

Occurrence:—Common in black shales of the lower or middle Liassic Kitamatadani formation of Kuruma group at Ohishi in Kotaki and at the mouth of Yogurazawa in Odokoro, Itoigawa

City, Niigata Pref. A solitary specimen procured by KANAYAMA* from the same formation at Kitamatadani, Kurobe national forest, Toyama Pref.

Chlamys sp. indet.

Plate 20, Figure 6.

Represented by internal and external moulds of a broken right valve (MM 2704). Shell medium, acline, more or less higher than long; byssal area of *Chlamys*-type with a byssal notch and distinct ctenolia.

This differs from normal *Chlamys* in the extraordinarily fine radial lines and the absence of concentric markings on the shell-surface.

Occurrence: – Sandstone of Kuruma group at Kamikawara in Kuruma. A similar fragmentary specimen from a sandstone of the Domerio-Toarcian Shinatani formation at Kanayamadani, Omi-machi, Niigata Pref.

Genus *Camptonectes* MEEK, 1864

Type species: – *Pecten lens* SOWERBY (1818), Middle and Upper Jurassic.

Remarks: – *Camptonectes* MEEK flourished world-widely in the Jurassic and Cretaceous. Its ancestral forms appear already in the Upper Permian (NEWELL, 1937). The Late Palaeozoic species have "*Camptonectes*-striations", although the byssal notch is shallower than in Mesozoic typical forms. The roof-shaped dorsal margins show that those forms are more similar to the Aviculopectinidae, as mentioned by NEWELL. Recently *Camptonectes triadicus* NAKAZAWA (1952) and *C.* (?) sp. by ICHIKAWA (1954 b) were described from the Upper Triassic in Japan. The former species is provided with undoubted "*Camptonectes*-striations", but the auricles are not so clearly outlined as in Jurassic forms.

On the basis of the surface ornamentation Cox (1952) divided this genus into the following three groups:

(1) *lens*-group (*Camptonectes* s. s.) provided with fine flabellate, often punctate "*Camptonectes*-striations".

(2) *annulatus*-group with erect concentric laminae at more or less regular intervals.

(3) *intertextus*-group (*Camptochlamys* ARKELL 1930) with lattice ornamentation.

There is, however, another group characterized by an almost smooth surface. It comprises *Camptonectes torinosuensis* KURATA and KIMURA, *C.* (?) *mimikirensis* K. and K. (KIMURA, 1951) and four Liassic forms described below. This group lacks entirely "*Camptonectes*-striations" or any striking radial or concentric costae, and the outline is often flabellate and somewhat longer than high. It should be distinguished from *Camptonectes* (s. s.) at least subgenerically, but the writer's materials are so poor that he hesitates to establish a new subgenus or genus for them.

"*Camptonectes*" *oishii*

KOBAYASHI and HAYAMI, new species

Plate 20, Figures 7–10.

Description: – Represented by three right subinternal moulds and a fragmentary right valve. Shell medium, orbicular in outline exclusive of auricles, more or less opisthocline, highly inequilateral with well expanded anterior area, a little convex, slightly longer than high (holotype: 30.5 mm. long; 28.5 mm. high); antero-dorsal margin of shell-body pronouncedly concave; postero-dorsal and hinge-margins nearly straight; ventral margin gently arcuate but curvature becomes very strong near the antero-dosral one; auricles very unequal; anterior one protruded, linguiform, supported by a narrow byssal sulcus; byssal notch wide and profound; posterior auricle triangular, horizontally elongated, rounded at the extremity, well defined from shell-body by a shallow groove; surface of subinternal mould marked with fine concentric lines and numerous faint radial capillae which probably indicate shell-structure of inner layer; ventral margin marked with about 80 (assumed) crenulations, which show the presence of radial ornaments on ventral surface.

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* The writer expresses his thanks to Mr. Ichiro KANAYAMA for the donation of the specimen.

Observation and Comparison:—The holotype (MM 2705, Fig. 8) is a right subinternal mould. Its shell-surface is almost exfoliated except for a byssal area, where faint radial ornaments are bared. In a fragmentary right valve (MM 2706, Fig. 10) the shell-surface is marked with very weak radial foldings which become more or less prominent towards the ventral margin, although they are not "*Camptonectes*-striations".

In some respects it resembles *Radulonectites* HAYAMI (1957), but the radial markings (striations in *Radulonectites*) are more numerous and weak, and the orbicular outline is more similar to *Camptonectes*.

Pleuronectites SCHLOTHEIM is characterized by almost smooth surface and a sigmoidal antero-dorsal margin, but the height is slightly but persistently greater than the length in *Pleuronectites* and *Radulonectites*, while it is the reverse in this species. Incidentally, the occurrences of *Pleuronectites* are restricted in the Triassic, so far as the writer is aware.

Camptonectes torinosuensis KURATA and KIMURA (KIMURA, 1951) from the Upper Jurassic Torinosu group in Sakawa basin seems the closest ally to this and probably congeneric with this, but the byssal notch is much narrower in *torinosuensis* than in this species.

Occurrence:—Rare in black shales at Kuruma, Kitaotari-mura, Nagano Pref. (Prov. of Shinano) and at Ohishi in Kotaki, Itoigawa City, Niigata Pref.

"*Camptonectes*" *subflabelliformis*
HAYAMI, new species

Plate 20, Figures 11, 12.

Description:—Two small right valves are at hand. Shell small, subequilateral exclusive of auricles, acline, flabelliform, slightly convex, much longer than high (holotype: 20.0 mm. long; 17.0 mm. high); antero-dorsal margin of shell-body slightly sinuated, while postero-dorsal one is long and nearly straight; apical angle about 115 degrees; hinge-line straight; anterior auricle large, protruded, defined from shell-body by a very narrow byssal sulcus; byssal notch rather shallow and angular; posterior one trigonal, depressed, truncated with an obtuse angle of about 120 degrees at the extremity; surface smooth except for several obscure irregular concentric undulations in umbonal area, lacking any radial markings; byssal auricle marked by numerous fine concentric lines; ctenolium and resilifar unknown.

Observation and Comparison:—The holotype (MM 2709, Fig. 11) is an almost complete right external mould. This species is fairly different from normal *Camptonectes* in the flabellate outline, large apical angle and smooth surface.

This differs from *Camptonectes torinosuensis* KURATA and KIMURA in the more equilateral shell-body and less concave antero-dorsal margin. *Camptonectes* (?) *mimikirensis* KURATA and KIMURA has regular concentric lines on the surface and is much larger than this, although the outline is fairly similar. In the flabellate outline this is also similar to *Pecten jamoignensis* TERQUEM and PIETTE (1868) from the lower Lias in the eastern Paris basin, but that species has "*Camptonectes*-striations" on the shell-surface. *Pecten praemissus* BITTNER (1901) from the Carnic in Bakony and *Camptonectes* (?) sp. by ICHIKAWA (1954 b) from the Carnic Arai formation in Tokyo Pref. have almost smooth shell-surfaces, and ICHIKAWA suggested that they are distinguishable from *Camptonectes* in generic rank. In this species, however, the outline is more flabellate with large apical angle, if compared with those Triassic forms.

Occurrence:—Rare in black shales at the mouth of Yogurazawa in Odokoro and at Ohishi in Kotaki.

"*Camptonectes*" a sp. indet.

Plate 20, Figure 13.

Represented by a large external mould of right valve (MM 2711) whose posterior side is broken off. Shell inequilateral, flabelliform, much longer than high with rather weak shell-convexity (74.0 mm. long; 61.0 mm. high); hinge-margin straight and very long; antero-dorsal margin gently sinuated; apical angle unusually large and about 130 degrees or more; anterior auricle well developed, protruded, marked by lattice of radial and concentric elements; byssal sulcus very narrow; byssal notch narrow but extraordinarily profound; surface very smooth except for irregular concentric foldings.

This differs from the preceding in the much larger dimension, profound byssal notch, larger apical angle, inequilateral shell and netted byssal auricle. The writer could find no comparable species.

Occurrence:—Sandstone of the Domerio-Toarcian Shinatani formation of Kuruma group at the upper stream of Kanayamadani in Omi-machi, Niigata Pref.

"*Camptonectes*" b sp. indet.

Plate 20, Figures 14, 15.

There are two small ill-preserved right valves (MM 2712, 2713). Shell subequilateral and acline exclusive of auricles, slightly higher than long; antero-dorsal margin of shell-body almost straight or slightly sinuated; apical angle 95 degrees or so; byssal auricle protruded forwards, defined from shell-body by a narrow byssal sulcus; byssal notch shallow, angular; surface smooth except for fine concentric lines of growth.

This form is more or less similar to typical *Camptonectes* in the external aspects, although "*Camptonectes*-striations" are not seen.

Occurrence:—Rare in a black shale at Ohishi in Kotaki.

Genus *Eopecten* DOUVILLÉ, 1897

=*Velata* QUENSTEDT (1856) non GRIFFITH (1834); *Velopecten* PHILIPPI (1898).

Type species:—*Spondylus tuberculosus* GOLDFUSS (1836), Dogger.

Eopecten (?) sp. indet.

Plate 20, Figure 16.

Two left external moulds before hand are a little broken and deformed secondarily. Shell almost acline, subequilateral, well convex, higher than long (illustrated specimen, MM 2714, 26.5+ mm. long; 33.5+ mm. high); postero-dorsal margin of shell-body almost straight; posterior auricle triangular, ill-defined, obtusely truncated at the extremity; surface ornamented with strong radial costae in two orders of prominence; primary ones diverging from umbo, numbered about 35; secondary ones appear by insertion in middle stage, almost regularly alternating with primaries; costae distributed also on posterior auricle; numerous fine concentric lines of growth crossing costae and their interspaces.

The ornamentation and strong convexity of shell remind one of a left valve of *Eopecten*, although the radial costae are numerous, if compared with those of typical species. This form is probably related to *Velata anglica* Arkell and *Velata wiltoniensis* Arkell (1931) from the Corallian in England, but the distinction between primary and secondary costae in left valve is more clear than in those Corallian species.

It is known to Kobayashi and Ichikawa (1949) that radial costae often increase their number by insertion in the left valve of *Chlamys mojsisovicsi*, but the alternation of the costae of two orders is more regular in this form.

Occurrence:—Rare in black shales of Liassic Iwamuro formation near the Iwamuro Power Plant in Akagine-mura, Gumma Pref. This is an important marine element in the formation.

Family **Amusiidae** Ridewood

Genus *Entolium* Meek, 1864

=*Synclonema* Meek (1864); *Protamussium* Verrill (1899).

Type species:—*Pecten demissum* Phillips (1829), Dogger.

Entolium sp. indet.

Plate 20, Figure 17.

Only an ill-preserved left valve (?) (MM 2717) is at hand. Shell equilateral, gently convex, subvertically elongated, oblong in outline with subequal triangular auricles; surface smooth; internally, a pair of cardinal crura running close and subparallel to antero- and postero-dorsal margins of shell-body. Judging from the almost straight hinge-line, it may be a left valve of *Entolium*, but its specific identification is impossible.

Occurrence:—Sandstone at Kamikawara in Kuruma.

Genus *Variamussium* Sacco, 1897

Variamussium (?) sp. indet.

Plate 20, Figure 18.

A very small specimen (MM 2718) devoid of auricular area. Shell equilateral, acline, circular, as high as long (3.6 mm. long; 3.8 mm. high); surface marked with 10 strong radiating ribs which are very narrow and somewhat roof-like. It appears a right valve of *Variamussium*, but the material is too poor for determination.

Occurrence:—Black arenaceous shale of Domerian Teradani formation (*Amaltheus-Canavaria* bed) of Kuruma group at Teradani in Kuaobe national forest, Toyama Pref.

Explanation of Plate 20

Chlamys kurumensis KOBAYASHI and HAYAMI, new species. .... p. 119

Fig. 1 a. External mould of a right valve, Holotype (MM 2697) ×1.5. Loc. sandstone of Kuruma group at Kamikawara in Kuruma, Kitaotari-mura, Nagano Pref. KOBAYASHI coll.

Fig. 1 b. Gypsum cast of the same specimen.

Chlamys cf. *kurumensis* KOBAYASHI and HAYAMI .... p. 120

Fig. 2 a. Gypsum cast of external mould of a right (?) valve, × 1.

Fig. 2 b. Internal mould of the same specimen (MM 2699) × 1. Loc. ditto. KOBAYASHI coll.

Chlamys kotakiensis TAKAI and HAYAMI, new species. .... p. 121

Fig. 3. Right valve, Paratype (MM 2701) × 1. Loc. black shale of Kitamatadani formation at the upper stream of Kitamatadani in Kurobe national forest, Toyama Pref. KANAYAMA coll.

Fig. 4. Left valve (MM 2702) × 1. Loc. black shale of the same formation at Ohishi in Kotaki, Itoigawa City, Niigata Pref.

Fig. 5. Left valve, Holotype (MM 2700) × 1. Loc. ditto.

Chlamys sp. indet. .... p. 122

Fig. 6. Internal mould of a right valve (MM 2704) × 1. Loc. same as Fig. 1 a.

"*Camptonectes*" *oishii* KOBAYASHI and HAYAMI, new species. .... p. 122

Fig. 7. Subinternal mould of a right valve, Paratype (MM 2707) × 1. Loc. black shale of Kuruma group at Kuruma, Kitaotari-mura, Nagano Pref. KOBAYASHI coll.

Fig. 8. Subinternal mould of a right valve, Holotype (MM 2705) × 1.5. Loc. ditto. KOBAYASHI coll.

Fig. 9. Subinternal mould of a right valve (MM 2708) × 1.5. Loc. ditto. KOBAYASHI coll.

Fig. 10. Right valve (MM 2706) × 1. Loc. same as Fig. 4.

"*Camptonectes*" *subflabelliformis* HAYAMI, new species. .... p. 123

Fig. 11. Gypsum cast of external mould of a right valve, Holotype (MM 2709) × 1.5. Loc. black shale at the mouth of Yogurazawa in Odokorō, Itoigawa City, Niigata Pref.

Fig. 12. Right valve (MM 2710) × 1.5. Loc. same as Fig. 4.

"*Camptonectes*" a sp. indet. .... p. 124

Fig. 13. Gypsum cast of external mould of a right valve (MM 2711) × 1. Loc. sandstone of Shinatani formation at Kanayamadani in Omi-machi, Niigata Pref.

"*Camptonectes*" b sp. indet. .... p. 124

Fig. 14. External mould of a right valve (MM 2712) × 2. Loc. same as Fig. 4.

Fig. 15. Right valve (MM 2713) × 2. Loc. ditto.

Eopecten (?) sp. indet. .... p. 125

Fig. 16. Gypsum cast of external mould of a left valve (MM 2714) × 1. Loc. black shale of Iwamuro formation near the Iwamuro Power Plant in Akagine-mura, Gumma Pref.

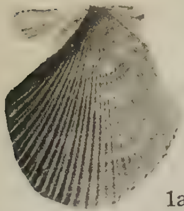
Entolium sp. indet. .... p. 125

Fig. 17. Left (?) valve (MM 2717) × 1. Loc. same as Fig. 1 a. KOBAYASHI coll.

Variamussium (?) sp. indet. .... p. 125

Fig. 18. Left (?) valve (MM 2718) × 1. Loc. sandy shale of Teradani formation (*Amaltheus-Canavaria* bed) at Teradani in Daira, Asahi-machi, Toyama Pref.

All illustrated specimens are kept in the Geological Institute, University of Tokyo.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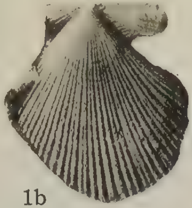
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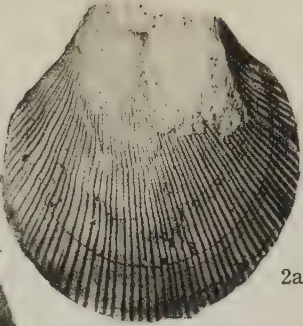
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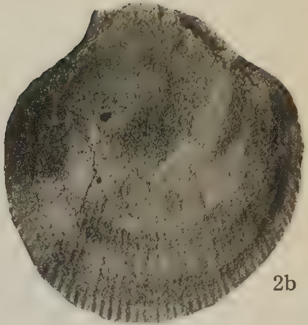
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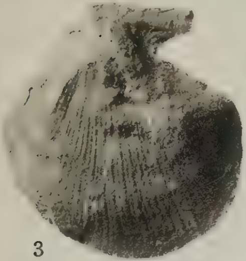
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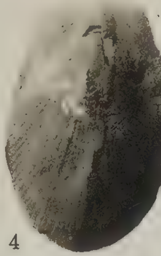
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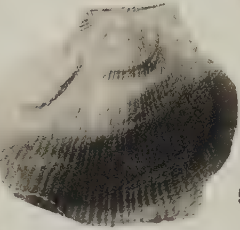
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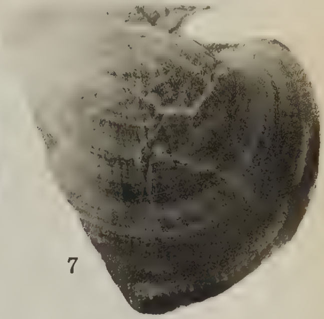
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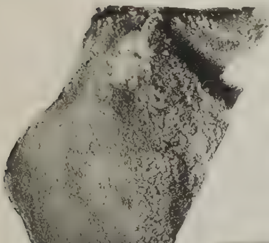
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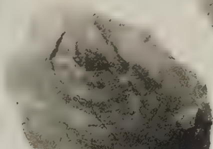
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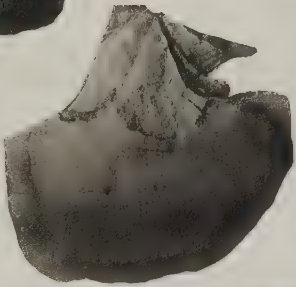
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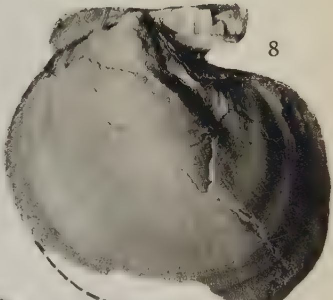
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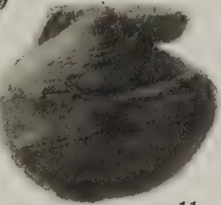
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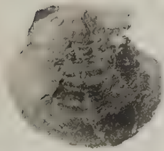
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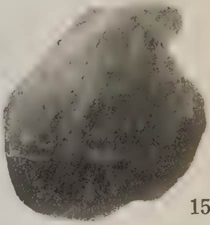
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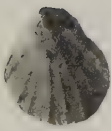
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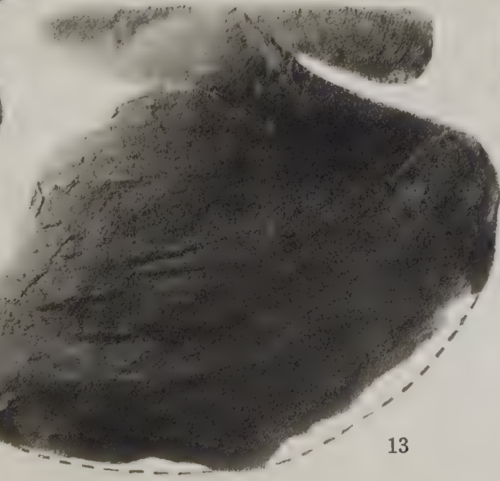
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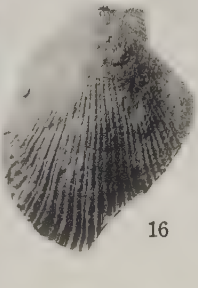
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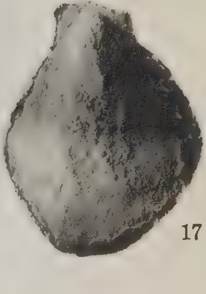
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Photo by Mrs. KOBAYASHI and Mr. UEKI

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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 28, pp. 128-136, pl. 21, Dec. 15, 1957

327. ON SOME JURASSIC RHYNCHONELLIDS FROM SHIKOKU, JAPAN*

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四国外帯の侏羅系産の Rhynchonellids 7 種：内 2 種は阿波桜谷地域の宮子谷層産で，それぞれ *R. haradai*, *R. boucharaii* に近縁で，Lias を指示するものと思われる。土佐七良谷層産の 2 種の内 1 種は *Kallirhynchia*, 他は佐川四近の鳥巣統産の 2 種と共に *Burmirhynchia* に属する。この属は，Burma の Namyau Bed を始め Tethys, Asia の Bathonian, Callovian (?) に広く分布するが，七良谷産の *B. japonica* n. sp. により新たに内部構造が判明した。鳥巣統産の他の 1 種は *Parvirhynchia* に属する。

徳 山　明

Seven Rhynchonellids procured from the Jurassic strata in the outer zone of Japan are described in this paper, namely, 2 of which are from the Liassic (?) Miyakodani formation in Awa (Tokushima Pref.), another 2 from the Naradani of the Dogger age in Tosa (Kochi Pref.) and the remaining 3 from the Torinosu series of the Malm age also in Tosa.

Rhynchonella haradai NEUMAYR (1890) has been a solitary rhynchonellid in the Jurassic fauna of Japan, and unfortunately its exact locality is unknown. It was compared by NEUMAYR with *R. furcillata* THEODORI from the Lias of Western Europe. The Miyakodani rhynchonellids are also suggestive of Liassic age. One is the *laevis* form related to *R. bouchardii* DAVIDSON from the upper Lias of England, while the other is a capillate one closely resembling *R. haradai*. One of the Naradani species belongs probably to *Kallirhynchia* BUCKMAN, and the other to *Burmirhynchia* BUCKMAN which is widely distributed in Bathonian of Europe and Asia. Two Torinosu species resemble also certain species of *Burmirhynchia*, and the other of the Torinosu species belongs to *Parvirhynchia* BUCKMAN.

The Torinosu series which is Malm in age according to KOBAYASHI (1935), is widely distributed in the Chichibu zone of Japan, whereas the pre-Torinosu Jurassic formations are found in the zone only at a few places in the Shikoku island. The Naradani formation is known in the west and south-west of Sakawa and yields an interesting Dogger fauna. The Liassic Miyakodani formation is so far restricted to a small area in Awa. Because Naradani and Miyakodani formations are widely apart from each other, their relation is not actually determinable, but it is quite certain that the Miyakodani and Naradani formations are located near the top of the Sambosan group. Their limited distribution is due to the extensive erosion caused by the emergence of the Middle Jurassic Hida phase (KOBAYASHI, 1941).

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The writer is grateful to Prof. T. KOBAYASHI under whose direction this investigation was carried out. His thanks are due also to Mr. K. HASHIMOTO at Usugatani in Awa and Mr. T. IMAMURA at Sakawa for the privilege of describing their collection.

Description of species

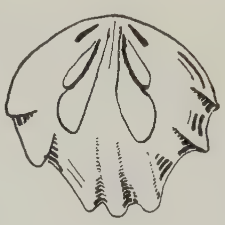
Genus *Rhynchonella* FISCHER DE WALDHEIM, 1809 (sensu lato)

"*Rhynchonella*" sp. cfr. *haradai* NEUMAYR, 1890

Plate 21, Figures 1–3; Text-figure 1.

cfr. *R. haradai* NEUMAYR, (1890) *Denkschr. k. Akad. wiss. Math.-Naturw., Bd. 57*, S. 32, Taf. 5, Fig. 5.

Description:—Shell small, roundly tetragonal. Brachial valve rounded, moderately convex and provided with a median fold which is broad, elevated above major part of shell; 3 of 7 ribs on median fold, sharp, subangulate, and suddenly disappearing within umbonal half. Median sinus of pedicle valve wide, acute, somewhat geniculated at base; anterior lobe projected in form of trapezoid; anterior commissure folded up also in a similar form; ribs starting a little below beak, distinct, rounded. Beak small, and suberected. Capillae fine, distinct and continue to costation (fig. 1b).



Text-figure 1. "*Rhynchonella*" cfr. *haradai*; showing the dorsal muscle scar. ×3.

Internally, median septum of brachial valve narrow, very shallow and extending for a half of shell-length; dental lamellae divergent, short and supporting hinge teeth of common rhynchonellid type; hinge socket tolerably well impressed and coarsely crenulated. Dorsal anterior adductor elongate-oval or triangular; its inner margin slant toward median septum, and then running parallel to septum; its longest part parallel and close to narrow and short posterior scar. Ventral scars indistinct.

Measurement in mm.	Length	Width	Thickness
Both valves (fig. 2)	12. 2	16. 3	3. 3
Pedicle valve	12. 8	15. 0	—
Brachial valve (fig. 3)	12. 2	11. 1	—

Observation and Comparison:—An internal mould of both valves and several external moulds at hand are badly deformed. Ribs on the median sinus number 3 in a specimen.

The above described "geniculation" of the median sinus may be produced by deformation. If so, this is almost indistinguishable from the typical *R. haradai* in the external view. The interior of the typical form is unknown.

This resembles *Parvirhynchia* BUCKMAN (1917) closely, but it can be distinguished by the absence of the *Norella*-

stage, and the aspect of muscular impressions. Internally, this resembles *Kallirhynchia* Buckman, especially in the shape of dorsal muscle scars, but the resemblance may be superficial, because it belongs to the *laevis* group. From *Burmirhynchia* Buckman it differs in its fairly strong median sinus and muscular impressions. In *Burmirhynchia* anterior and posterior dorsal scars are combined in cordi- or pyri-form, while they are separated in this species. Thus the writer failed to find any genus in which it can safely included.

"*Rhynchonella*" *richardsoni* Muir-Wood, probably from the Lias, is very similar to this in outline, but the median sinus is narrower, the anterior lobe less prominent and the shell capillate in this. As she pointed out (1936, p. 48) the broad rounded costae on the anterior portion and anterior lobe such as in these species are strongly suggestive of the alliance to some Lias species such as "*R.*" *jurensis*, "*R.*" *variabilis*.

Occurrence:—Common in the Miyakodani formation at Kohama in Awa. The Lias age of this formation is suggested by 2 species of rhynchonellids therein. Neumayr's specimen is said to have been collected at Kaisekiyama, near Sakawa in Tosa, where, however, no Liassic formation is known.

"*Rhynchonella*" sp. aff. *bouchardii* Davidson

Plate 21, Figure 4.

aff. *R. bouchardii* Davidson, (1851) *British Fossil Brach., pt. 3*, p. 82, pl. 15, figs. 3, 5.

A pedicle valve, 13.5 mm. long, 15.5 mm. wide, gently convex and circular. It is smooth in immature stage but about 11 prominent and more or less rounded plicae appear suddenly in a certain stage of growth; central one lies on the median sinus which appears near the centre of the shell; rounded concentric lines of growth discernible near its periphery. Internally, dental lamellae are short, strong and subparallel; muscle impressions are obscure.

This differs from Davidson's in its more distinct median sinus, but coincides with the latter in convexity, outline, plication and so forth. *R. nauninae* Finkelstein from the upper Lias of South Tirol is another ally which, however, is distinguished from this by the distinct median sinus and more widely spaced plicae in that species. Upper Triassic "*R.*" *nakajimensis* Tokuyama (1957) has a similar outline and plication, from which, however, this differs in its more rounded outline, in the gently inflated pedicle valve and in the roundly sinuated median sinus.

Short plicae, rounded even outline and other characteristics as seen these species are also recognized in one of the Triassic rhynchonellid sections (Tokuyama, 1957). Rothopletz (1886) proposed *Prona*-Sippe for the lower Liassic "*R.*" *prona* Oppel (1861) and upper Liassic "*R.*" *bouchardii*. The present species is another Liassic member of the group. Writer is of opinion that these 4 Liassic forms were derived from the Triassic *griesbachi* section.

Occurrence:—Rare in the Miyakodani formation at Kohama, Awa.

Genus *Kallirhynchia* Buckman, 1914

1917: *Kallirhynchia* Buckman, *Pal. Indica, N.S., vol. 3*, p. 31.

1934: *Kallirhynchia*, Muir-Wood, *Phil. Trans. Roy. Soc., ser. B., vol. 223*, p. 534.

Kallirhynchia sp. indet.

Plate 21, Figure 11.

A pedicle valve, 11.8 mm. long and 13.5 mm. wide, is roundly trigonal and convex, but is flattened mesially. The shell is ornamented by 22 persistent costae which are distinct, subangular anteriorly and separated by deep and narrow sulci; median sinus flattened and defined anteriorly, carrying a short linguiform extension and provided with 6 costae. Umbo is incurved and somewhat gibbous; foramen unknown.

Either muscle scars or other interior features are unknown. The general external view is, however, suggestive of *Kallirhynchia* for it. In the outline, costation and number of ribs it resembles *K. amoena* BUCKMAN and *K. decora* BUCKMAN.

According to BUCKMAN the genus ranges from Bajocian to Callovian.

Occurrence:—Rare at the mouth of Naradani valley, near Nishiyama, Togano in Tosa, in the upper part of the Naradani formation.

Genus *Burmirhynchia* BUCKMAN, 1915

1915: *Burmirhynchia* BUCKMAN, *Rec. Geol. Surv. India, vol. 45*, p. 76.
1917: *Burmirhynchia* BUCKMAN, *Pal. Indica, N.S., vol. 3, no. 2*, p. 49.

This genus comprises 40 species from the Namyau bed of Burma and 18 Bathonian and Callovian (?) ones from England, France, Somaliland, Syria, Arabia, Attock, China (Yunnan) and Australia (?); 3 species are added here to them. The genus belongs probably to the *laevis* group by BUCKMAN. In spite of his capillate shells the writer identifies them with *Burmirhynchia* with emphasis on the *B. namyauensis* type of interior characters, especially on the muscle scar which is one of the most important characteristics of the genus. BUCKMAN (1917) did not discuss the surface features. It is true that some species belong to the *laevis* group, *B. hsipawensis* BUCKMAN for instance, but some others belong to the *capillatae*. *B. ovalis* for example, has capillate shells as shown in his illustration. Thus this genus comprises the two groups. A future study may promote them to the generic rank. According to SAHNI (1928) and MUIR-WOOD (1934) the difference between the capillate and *laevis* groups does not bear great importance in the phylogeny of terebratulids. This may be true also for rhynchonellids, because *B. japonica* bears the similar crura to the group of *laevis Kallirhynchia* and others. According to MUIR-WOOD (1939) capillate *Parvirhynchia* has also the similar type of crura. Phylogenetically the crural character, which is of prime importance, suggests that this genus may be related to these genera.

Burmirhynchia is an important genus of the Dogger and the lowest Malm in the Tethys and Asia.

Burmirhynchia japonica TOKUYAMA, new species

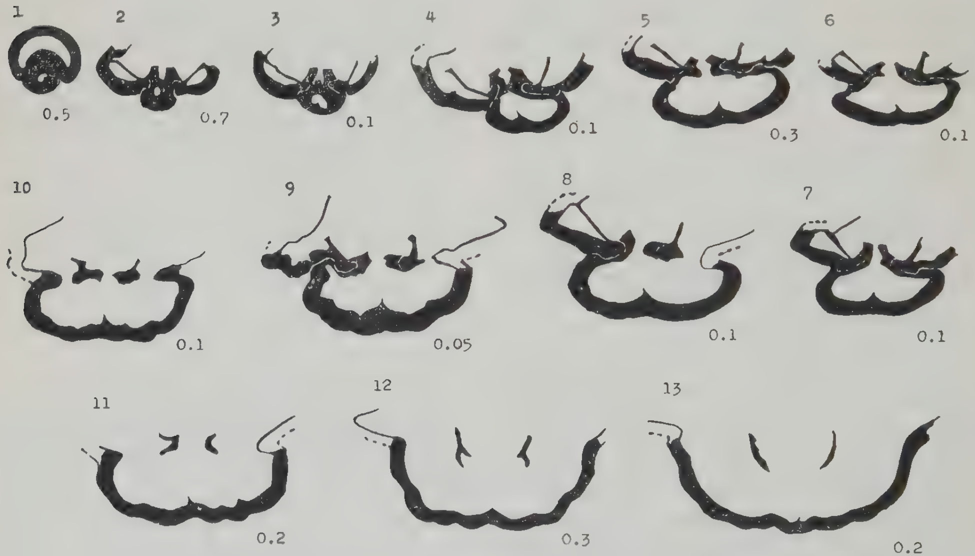
Plate 21, Figures 5, 6; Text-figure 2.

Description:—Shell small for the genus, biconvex and roundly subtetragonal. Brachial valve gently inflated with a low median fold in anterior third. Pedicle valve more or less flattened; sinus shallow, distinct only in anterior. Anterior commissure elevated trapezoidally; lateral commissure slanting ventrally; beak small, short, submesothyrid and slightly gibbous; foramen small and subcircular; about 15 ribs inclusive of 5 mesials on pedicle valve, more or less angular and abruptly weakened mesially. Weak and short capillae distributed on whole surface.

Measurement in mm.	Length	Width	Thickness
Holotype (fig. 5)	8.7	12.2	6.1
Paratype (fig. 6)	8.4	8.6	4.5

Observation;—Thin tests are preserved in a few specimens. The serial section of the posterior portion and artificial internal mould show the internal structure (Text-figure 2). Dental lamellae are short and fairly strong, but thin, diverging at 20 degrees and supporting narrow, short and cuneiform in transverse section, extending for one-third of the shell length; it is split away from the septalial plates in the very early stage; septalium more or less deep; a small projection exists in the anterior; hinge plate slightly concave, strongly demarcated by an inner socket-ridge. Dental lamellae, hinge plates and septalial plates are fused to form W in transverse section near umbones. Crura probably of "calcifer" type, consists of two thin curved laminae which are concave anteriorly and dorsally. They are combine to describe a semicircle.

Muscle scars are obscure, but by cross light they are found to be similar to those of *B. namyauensis*; namely, 2 anterior dorsal scars are narrow and occupy two-thirds of the shell-length and connected with posterior ones which are a little more strongly im-



Text-figure 2. *Burmirhynchia japonica.* 13 transverse sections through posterior portion of shell. × 8.

pressed than the anterior ones; anterior and posterior pairs of scars are united to make a cordate form; posterior ventral scar is large and subrhomboidal; 2 anterior scars are separated from the preceding by narrow furrows.

Comparison:—Among the Namyau species *B. namyauensis* BUCKMAN is closest to this, although the convexity is greater and ribs are more distinct and numerous in BUCKMAN's. He did not mention of its surface ornament, but the close resemblance of interior characters suggests both species to be congeneric. *B. subtrigonalis* BUCKMAN is another ally to this species, but the disagreement is in its prominent, incurved and gibbous beak. *R.* aff. *varians* by WANNER & KNIPSCHEER from the Lias of East Seran is a close ally, but ribs are more numerous and a little stronger in that species.

Its crura may be similar to those of *Kallirhynchia* or "calcifer" type (MUIR-WOOD, 1934), although the second lamina is not distinct. From *Kallirhynchia* it is distinguished by its characteristic muscular impression, weaker and more rounded costae, anterior portion of shell, and so on.

Occurrence:—Common at the mouth of the Naradani valley and "Jinden-no-shiba" on the eastern slope of Nishiyama valley, Togano near Sakawa in Tosa, in the Naradani formation. *Burmirhynchia* and associated terebratulid are Bathonian. KURATA (1941) suggested the Inferior Oolite for this fauna.

Burmirhynchia torinosuensis TOKUYAMA, new species

Plate 21, Figures 7, 8.

Description:—Shell small, roundly trigonal, biconvex, nearly equivalve and chestnut-like. Brachial valve fairly flat and feebly trilobed by intercalation of a very weak median fold in anterior. Pedicle valve gently convex; sinus insignificant, indicated only by a low undulation of anterior commissure which transmits into lateral ones; lateral commissure slants ventrally; beak small, short, erect and submesothyrid; foramen subcircular. Ribs in pedicle valve wide, distinct, rounded, separated by narrow sulci, weakened toward beak and numbered 15, 5 of which on median sinus fit in 4 ribs on median fold of brachial valve. Capillae short, distinct and running into costation.

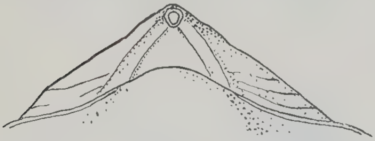
Measurement in mm.	Length	Width	Thickness
Holotype (Fig. 7)	9.0	9.2	5.2
Paratype (Fig. 8)	9.0	10.3	6.1

Observation and Comparison:—A fine complete specimen and a fragmentary one are found in limestone. The latter is more convex than the former. Such a convex form is rather common in this genus, as exemplified by *B. namyauensis* and *B. prvestans* REED. This species resembles *B. japonica* in its biconvex shell, beak region, comparatively weak median sinus, capillae like ornament and in the number of ribs so closely that they are thought to belong to the same genus, but the interior is unknown of this species. It is distinguished from the preceding by its indistinct median sinus and more rounded and wider costae. *B.* cfr. *parva* by MUIR-WOOD (1937) bears nearly the same number of ribs and the outline similar to this, but its ribs are slightly stronger and the beak is more incurved than in this species. Among the Namyau species *B. namyauensis* and *B. subtrigonalis* are also similar to this species and especially to its convex paratype. This however, is distinguishable from them by its erect beak and more widely spaced rounded costae. From *B. prvestans* REED of Yunnan this is distinguished by the slender form. *R.* cfr. *haradai* is the oldest among the capillate species in Japan and bears the most clear-cut median sinus, while the sinus is most obscure in this. The Naradani species is intermediate between them.

Occurrence:—Rare at Hanabata and Iwasa-yama, near Sakawa in Tosa, in the lower part of Torinosu series.

"*Burmirhynchia*" *capillata* TOKUYAMA, new species

Plate 21, Figure 9; Text-figure 3.



Text-figure 3. Beak of "*Burmirhynchia*" *capillata.* × 6.

Description:—Shell small, biconvex, fairly flattened, nearly equivalve and broadly elliptical. Brachial valve subrounded, broadly inflated; median fold almost obscure, only defined by gradual elevation of anterior commissure. Pedicle valve not gibbous, with a shallow sinus near anterior margin; lateral commissure slightly incurved; beak ridges subangular; interarea rather high relative to foramen which is in turn small, suboval, and methothyrid (Text-figure 3). Ribs on pedicle valve 16 in number, including 4 mesials, all weak, rounded and effaced toward beak. Whole surface covered with fine capillae; concentric ornament absent except a few growth lines.

Observation and Comparison:—Only one good specimen at hand is 8.6 mm. long, 8.1 mm. wide and 3.8 mm. thick. In the external view it looks to be a *Burmirhynchia*, but this reference must be confirmed by the interior structure. In shell texture it is indistinguishable from the preceding. This is fairly similar to *B. depressa* BUCKMAN in outline, commissure, number of ribs, the smaller beak and the non-trilobed outline, but BUCKMAN's differs from this in the gibbous beak and more distinct costae. This is distinguished from *B. japonica* as well as *B. torinosuensis* by its slender outline, sharp beak, small foramen and weak costae.

Occurrence:—Rare at Iwasa-yama near Sakawa in Tosa, in the Torinosu limetone.

Genus *Parvirhynchia* BUCKMAN, 1914

1917: *Parvirhynchia* BUCKMAN, *Pal. Indica, N. S., vol. 3, no. 2,* p. 56.
1939: *Parvirhynchia;* MUIR-WOOD, *Proc. Geol. Ass., vol. 50,* p. 476.

Parvirhynchia bella TOKUYAMA, new species

Plate 21, Figure 10.

Description:—Shell small, biconvex and rounded. Brachial valve gently convex; median fold elevated on anterior half, carrying 3 round costae;

anterior commissure folded up to form trapezoidal; *Norella*-stage passing in very early stage. Pedicle valve less convex, slightly trilobed and distinct anteriorly; lateral commissure slanting ventrally; beak hypothyrid, small, suberect and slightly incurved; foramen small and rounded; 8 costae including 2 mesials rounded, stout, widely spaced and developed on the anterior half; surface covered wholly with distinct and continuous capillae.

Observation and Comparison:—The type specimen, 8.2 mm. long, 8.1 mm. wide and 4.7 mm. thick is well preserved in oolitic limestone.

Internal characters are unknown except for slightly diverging dental lamellae and a cuneiform weak median septum. Nevertheless the species reveals several important characteristics of *Parvirhynchia*; namely hypothyrid beak, small circular foramen, early *Norella*-stage, rounded costae, and continuous capillae through the shell as emphasized by BUCKMAN.

From *P. parvula* BUCKMAN this is distinguished by its smaller beak, wider and more rounded outline; ribs are more distinct and more numerous in that than in this species. *P. kirtonensis* MUIR-WOOD (1939) is similar in dimension and has the same number of costae as this, but the foramen is larger and costae are more distinct in that species than this.

According to BUCKMAN and MUIR-WOOD this genus appears to have been flourished in Bajocian and survived until Oxfordian.

Occurrence:—Rare at Anaiwa at the mouth and on the southern slope of the Anaiwa valley, near Ogawa in Tosa, in the lower part of Torinosu series.

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Explanation of Plate 21

Sufixed letters in figs. 5, 7–9 show:– a: brachial view, b: lateral view, c: pedicle view, d: anterior view, e: posterior view.

Figs. 1–3: "*Rhynchonella*" sp. cfr. *haradai* Neumayr .... p. 130
1a, b: External mould of a brachial valve; a: × 3, b; its enlarged part showing capillae, × 7. Loc. Miyakodani, Usugatani in Awa.
2a–c: Internal mould of both valves viewed from 3 directions; a: pedicle view, b: brachial view, c: anterior view, × 3. Loc. Ditto.
3: Internal mould of a brachial valve, × 2; cfr. text-figure 1. Loc. ditto.
All Hashimoto coll.

Fig. 4: "*Rhynchonella*" sp. aff. *bouchardii* Davidson .... p. 131
Internal mould of a pedicle valve viewed from 2 directions; a: pedicle view, b: anterior view, × 3. Loc. Miyakodani. Hashimoto coll.

Figs. 5–6: *Burmirhynchia japonica* Tokuyama, new species. .... p. 132
5a–d: Holotype, internal mould of both valves, viewed from 4 directions, × 3. Loc. Naradani, near Togano, in Tosa.
6a–c: Paratype, internal mould of both valves, viewed from 3 directions; a: pedicle view, b: lateral view, c: anterior view, × 3. Loc. Jinden-no-shiba, near Togano in Tosa.

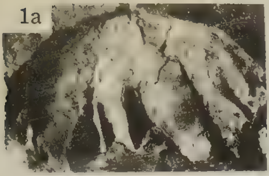
Figs. 7–8: *Burmirhynchia torinosuensis* Tokuyama, new species. .... p. 134
7a–e: Holotype, both valves, viewed from 5 directions; a: enlarged pedicle view showing the surface character of shell, × 5; b–e: × 2. Loc. Hanabata, near Sakawa in Tosa. Imamura coll.
8a–d: Paratype, internal mould of both valves viewed from 4 directions, × 3. Loc. Iwasa-yama near Sakawa in Tosa.

Fig. 9: "*Burmirhynchia*" *capillata* Tokuyama, new species. .... p. 135
9a–e: Holotype, both valves viewed from 5 directions, × 3; f: a part of the shell showing capillae, × 5. Loc. Iwasa-yama.

Fig. 10: *Parvirhynchia bella* Tokuyama, new species. .... p. 135
10a–d: Holotype, both valves, viewed from 4 directions, × 3. Loc. Anaiwa, Ogawa near Sakawa in Tosa.

Fig. 11: *Kallirhynchia* sp. indet. .... p. 132
An internal mould of a pedicle valve, × 3. Loc. Naradani.

All specimens illustrated here are kept at the Geological Institute, University of Tokyo.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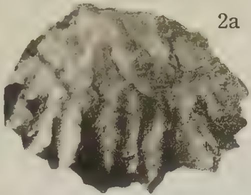
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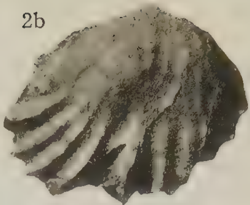
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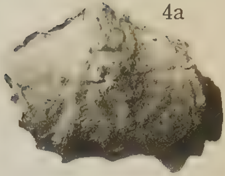
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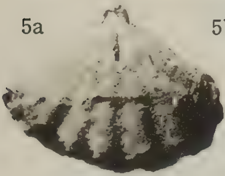
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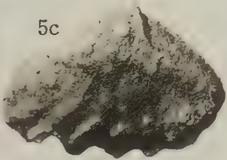
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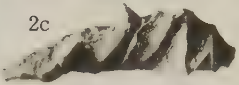
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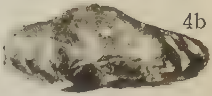
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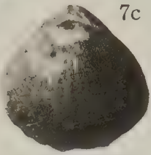
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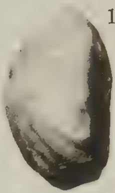
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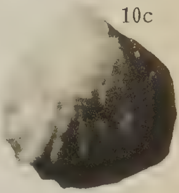
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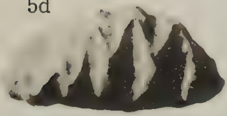
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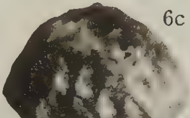
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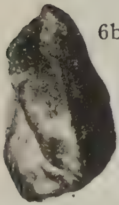
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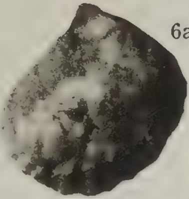
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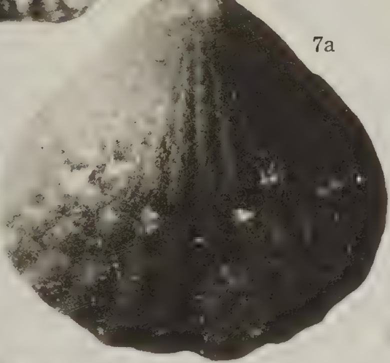
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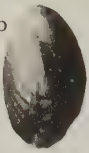
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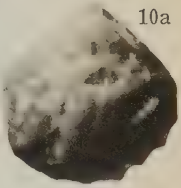
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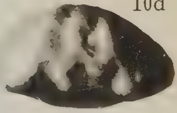
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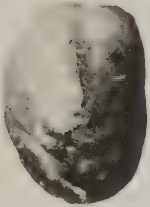
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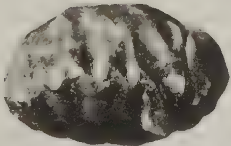
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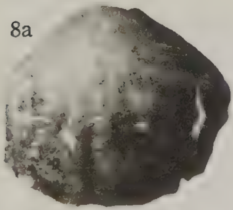
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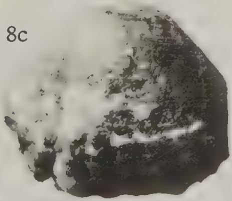
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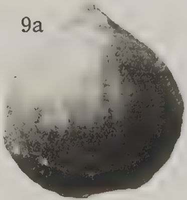
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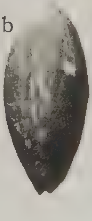
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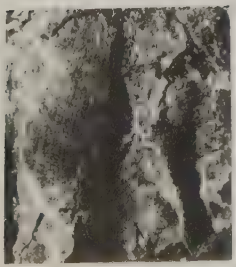
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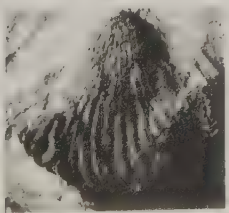
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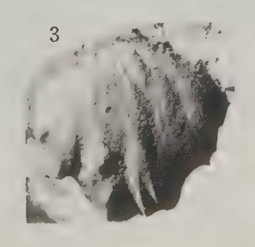
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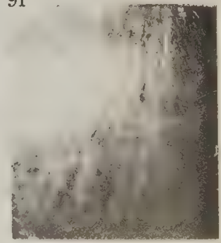
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UEKI Photo.

Trans. Proc. Palaeont. Soc. Japan, N. S., No. 28, pp. 137-142, Dec. 15, 1957

328. TWO CARBONIFEROUS CORALS FROM THE KITAKAMI MOUNTAINS, NORTHEAST HONSYU, JAPAN*

MASAO MINATO and MAKOTO KATO

Department of Geology and Mineralogy, Hokkaido University

北上山地の石炭紀層の珊瑚2種： 北上山地の石炭紀層から産した珊瑚の2種, *Diphyphyllum delicatum* Minato et Kato, sp. nov., *Clisiophyllum* sp. について記載する。後者は正確な産地と層準は不明であるが *Clisiophyllum m'coyanum* Thomson に類似する。 湊 正 雄・加 藤 誠

The present short note deals with two corals derived from the Carboniferous deposits developed in the Kitakami Mountain region, Northeast Honsyu, Japan, viz., *Diphyphyllnm delicatum*, sp. nov., and *Clisiophyllum* sp. The latter form closely resembles *Clisiophyllum m'coyanum* Thomson, but may perhaps belong to a new species.

Description of Species

Genus *Diphyphyllum* Lonsdale, 1845

Diphyphyllum delicatum, sp. nov.

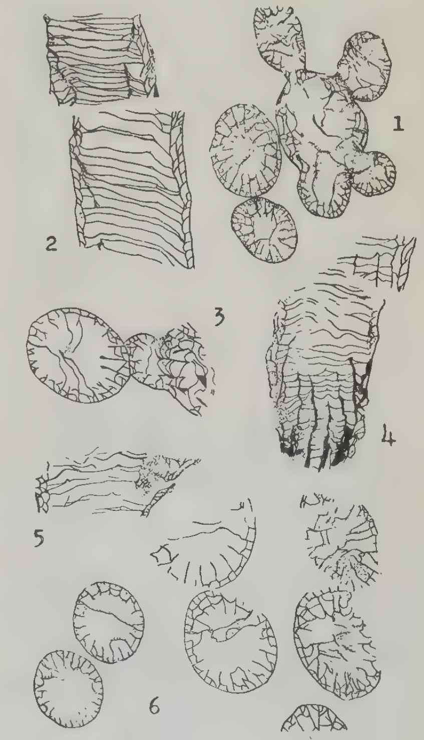
Text-figs. B(1-6), C.

Corallum compound, fasciculate and phaceloid. Corallites cylindrical, gently tapering downwards, rather closely disposed with each other, the interspace between them not exceeding the distance of their own diameter; if they are at maximum distance apart.

Epitheca thin, horizontally annulated on its surface, but no distinct septal grooves observable.

Type of increase, perhaps lateral and non parricidal.

In cross section, corallites round in



Text-fig. B.

Diphyphyllum delicatum Minato & Kato, sp. nov. (all figures ×1.5)

Fig. 1. Cross section showing "gemmation".
Fig. 2. Longitudinal section.
Fig. 3. Cross section, partly tangential.
Fig. 4. Longitudinal section, partly tangential.
Fig. 5. Longitudinal section in a part of "gemmation" of fig. 1.
Fig. 6. Cross section.

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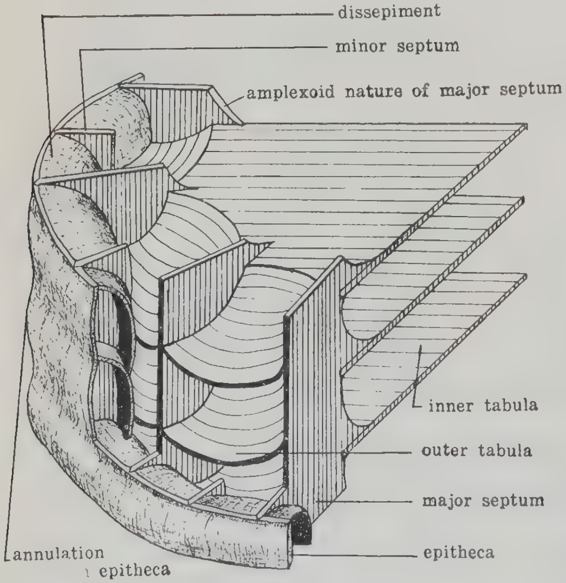
* Read Sept. 28, 1957; received Feb. 22, 1957.

outline, attaining 10 mm in maximum diameter. Septa in two orders, major and minor respectively, all of them arranged radially and somewhat flexious. Not only minor septa but also major septa are quite short, attaining a half or a third of the radius of the corallite, numbering 17 to 18 in a corallite of full grown stage. Even in a still earlier stage, the septal number 15 is rather constant for this species, and in this hystero-neanic stage the minor septa have also already appeared, although they are very short.

In some corallites, the distal ends of the neighbouring major septa unite with the tabulae to represent a kind of structure like a phyllotheca in cross section, but this is by no means a true phyllotheca. As will be later described, the outer tabulae rise gently from the inner margin of the dissepimentarium in the longitudinal section, and they unite with the flattened inner tabulae of the central area. Such inclined outer tabulae show concavity upwards, accordingly their cut edges appear in cross section with their concave sides faced outwards.

There is no fossula and no trace of axial structure, accordingly the central area of this coral seems to be well spaced in the cross section.

Dissepimentarium narrow, where single or rarely two rows of dissepiments are developed, which are generally arranged in concentric but sometimes in angulo-concentric pattern. The cut edges of the dissepiments, which are much inclined to the outer wall join with the major septa and thus the major septa appear to be forked towards the outer wall. However, in the corallites of the very early stages there are no dissepiments and the major septa are observable to be of a common plate form.



Text-fig. C.
Diagrammatic illustration of a part of corallite, *Diphyphyllum delicatum* Minato & Kato.

In longitudinal section, septa also flexious and amplexoid. Inner tabulae almost flat, rarely undulating, uniting with the inclined outer tabulae, although sometimes the former is not distinctly differentiated from the latter. Between the major septa, the outer tabulae incline towards the dissepimentarium as above stated, and may perhaps be slightly concave upwards, accordingly they show concave surface upwards between the major septa in the tangential section. The density of both tabulae ranges 6 to 10 in a vertical distance of 5 mm. Dissepimental vesicles rather irregular in form and size, gently inclined inwardly, arranged usually in one row but rarely in two rows. Density of dissepiments is 5 to 6 in a vertical distance of 5 mm.

Remarks:—The present form is characterized by its relatively large corallite, short and comparatively few septa, besides wide tabularium which is occupied by closely set and almost flat tabulae. The dissepimentarium is narrow; it is occupied by single row or rarely two rows of dissepiments.

In 1928, SMITH divided *Diphyphyllum* into two groups based on the structure of tabulae, *Diphyphyllum* α and β groups respectively. HILL in 1940 added one more group represented by *Diphyphyllum ingens.* Recently the senior author classified diphyphyllids into five groups and showed the relationship amongst them, together with the geological range of the five groups (M. MINATO, 1955).

The nature of the tabulae of the present form apparently belongs to his group 3 (= group of *Diphyphyllum ingens* of HILL), in which the inner tabulae are horizontal and the outer tabulae slightly concave. This group of *Diphyphyllum* is a most long lived form ranging from the Lower Carboniferous *Dibunophyllum* zone to the Permian in age. The present form was also found from the Middle Carboniferous Nagaiwa series in the Kitakami mountain region. Among several forms of *Diphyphyllum* belonging to group 3, the present one somewhat resembles *Diphyphyllum equiseptatum* YABE et HAYASAKA, also a good horizon indicator of the Nagaiwa series in the Kitakami mountain region. But the former has a larger corallite, numerous septa and more numerous dissepiments than the present form.

Some corallites in the early stage of *Tschussovskenia capitosa* described by DOBROLYUBOVA show features somewhat like the present species, especially the specimen figured by her as fig. 88 in plate XXX shows similarity with the present specimens now under consideration, but the Russian species possesses an axial structure in the mature stage, and there is not discernible any trace of an intimate relation between these two forms.

Horizon:—Middle part of the Nagaiwa series, perhaps the *Profusulinella* zone.

Locality:—Eastern slope facing toward Onimaru Pass, in Hikoroichi-Machi, Kesen-Gun, Iwate Prefecture.

Collector:—T. HASHIMOTO.

Registration number:—U. H. R. 12446 (i–ix).

Genus *Clisiophyllum* DANA, 1846

Clisiophyllum aff. *m'coyanum* THOMSON

Text-fig. A.

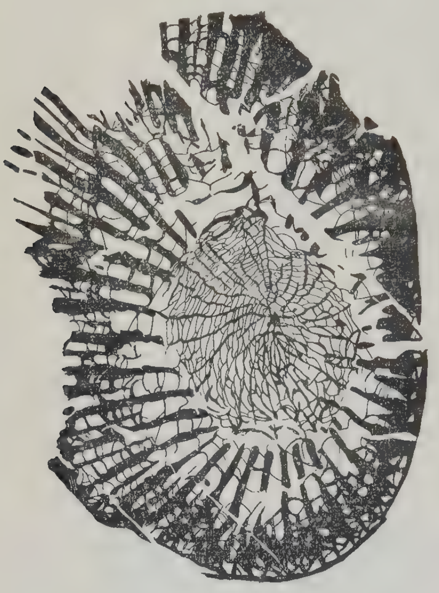
Compare, with;

Clisiophyllum keyserlingi, HILL (part), 1938; pp. 60–65, pl. 1, figs. 6, 11, *Clisiophyllum* aff. *m'coyanum*, SIBLY, 1908; pp. 73, 74, pl. 1, fig. 4.

Available for study there is only one oblique thin section which was made from the much deformed corallite.

Corallum simple. Corallite is elliptically outlined in the oblique section, attaining about 16 mm in the shortest diameter. Outer wall moderately thick. The outline of the outer margin of the wall is quite smooth in thin section, and accordingly there may be only indistinct septal grooves in the corallite.

Septa in two orders, both of them quite thickened throughout their length by stereoplasmic deposits, especially the major septa much dilated at the thecal region, and becoming slightly thin towards both axial and distal ends. The major septa usually straight, numbering about 40; they usually reach the axial complex and some of them unite with the septal lamellae, although the latter structure does not mean the mere elongation of the major septa.



Text-fig. A.
Clisiophyllum aff. *m'coyanum* THOMSON, (× 3)

In the thin section, both the major and minor septa are observable to be constructed from the three layers: the central layer is very narrow and translucent, on both sides of this translucent layer there are narrow black layers and still outside of them there are stereoplasmic layers formed of fibrous tissues which are perpendicularly arranged to the septal plane.

The minor septa alternating with the major one, fairly long and slightly protruding beyond the theca into the tabularium. They are also much thickened throughout their length as already noted.

Axial complex is large and free from any organic deposits; it is composed of an indistinct, somewhat flexious median plate, numerous axial tabellae and also a number of radiating septal lamellae, though they are less numerous than the major septa. Of them, the median plate only is composed of three layers: a translucent layer in the middle, and black layers on both sides of it. However, all of these three layers are quite thin and accordingly the width of the median plate is not so different from that of the other skeletal elements such as septal lamellae and axial tabellae. The septal lamellae are not straight and do not show the radial arrangement but rather show bilateral symmetry. The septal lamellae are somewhat twisted in both ends and rotating as a whole.

Fossula indistinct.

Dissepimentarium rather narrow, in comparison with the broader axial complex. The dissepiments are arranged in concentric to sub-concentric pattern.

Remarks:—Although the present material is quite imperfect, it seems to the writers to be specifically nearly like the Scottish Carboniferous species *Clisiophyllum m'coyanum* THOMSON, a specimen of which was illustrated by HILL (1938) as fig. 6 on plate 1 under the name of *Clisiophyllum keyserlingi* M'COY. Strong resemblance between the Japanese form an THOMSON's species consists especially in the much dilated major septa, long minor septa, and broad axial complex composed of rotating septal lamellae, numerous axial tabellae and median plate. It seems likely that the specimen now under consideration is quite nearly allied with THOMSON's species.

In the Japanese form, however, not only the major septa but also the minor septa are much dilated, and such feature is, according to Hill, never observable in the Scottish specimens. She stated that "the minor septa and the dissepiments also vary with ontogeny but they are never dilated". Such being the case, the writers wonder whether the Japanese form should be regarded as wholly synonymous with the Scottish species or not.

Hill is of the opinion that the variation in respect to the dilation of the septa must be regarded as almost negligible for any specific distinction and she grouped various types of *Clisiophyllum* into one species.

For example, she regarded such species as *Clisiophyllum m'coyanum* Thomson, and *Cyclophyllum paradoxicum* Thomson to be wholly synonymous with *Clisiophyllum keyserlingi* M'Coy. *Cyclophyllum paradoxicum* Thomson belongs to the genus *Clisiophyllum*, which has also much dilated major septa in the tabularium, but those major septa of this species are very thin in the dissepimentarium.

Sibly once described and illustrated one coral under the name of *Clisiophyllum* aff. *m'coyanum* Thomson, which is derived from D_2 zone in the Midland area of England. In his specimen the major septa are also thickened in the intrathecal area, but thin in the dissepimentarium and further no dilations are observable in the minor septa.

Also in the specimen of so-called *Clisiophyllum m'coyanum* illustrated by Hill, the major septa are not dilated in the dissepimentarium, although they are strongly thickened in the intrathecal area.

On the contrary, in the Japanese form, both the major and minor septa are much dilated by the stereoplasmic deposits throughout their length either in tabularium or in dissepimentarium. Accordingly the writers wish to regard this form as specifically distinct from the Scottish species, although it may be nearly related to *Clisiophyllum m'coanum* Thomson.

The present from may be a new species. However, the material now available for study is very imperfect and much deformed, and it may be reasonable to delay proposing a name until more numerous and complete materials may be collected.

Furthermore, the exact locality and horizon of the present form is unfortunately unknown to the writers. The specimen was found in a collection left by some university students who once engaged in a field survey of the Carboniferous deposits in the Kitakami district.

It is certain that this specimen was collected from the Setamai region in the Kitakami mountain district and from the Carboniferous deposits, but beyond this, nothing can be stated about its locality and horizon.

Meanwhile, it is the first representative from this country of the genus *Clisiophyllum* (s. str.). This genus is not common in Asia, though not lacking, so the record of the present form from Japan may be somewhat interesting.

Horizon:—Onimaru series or Nagaiwa series.

Locality:—Kitakami mountain district, but the precise locality is unknown.

Collector:—Unknown.

Registration number:—U. H. R. 12710.

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329. BRYOZOA FROM THE DAISHAKA FORMATION (PLIOCENE), MINAMI-TSUGARU-GUN, AOMORI PREFECTURE*

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青森県南津軽郡大釈迦層の蘚虫類：弘前盆地東縁に分布する大釈迦層（鮮新統）は多くの化石（有孔虫類、蘚虫類、腕足類、軟体動物、海胆類、甲殻類、石灰藻類等）を産する。今回は其の内模式地よりの蘚虫類化石を検討して34属54種を識別しその内6新種及び2新亜種を記載した。 片　岡　　純

Introduction and Acknowledgements

It is well known that Bryozoa remains occur in many sedimentary deposits of Japan, where they occur isolated or attached to molluscan and Brachiopoda shells and other foreign materials. However, there are very few studies concerning them.

I. Hayasaka (1924), K. Sakakura (1935, 1936) and S. Nomura (1936) are the only contributors on the fossil Bryozoa of Japan.

The purpose of the present work is to study the Bryozoa fauna of the Daishaka formation (Pliocene), which is typically developed in Minami-Tsugaru-gun, Aomori Prefecture in northern Honshû, Japan, from the view of its assemblage and paleoecology. Among the distinguished 34 genera and 54 species, six new species and two new subspecies are described in this paper. The specimens treated in the present work were collected from the type locality of the formation, which is the cliff situated on the right side of a small stream in the valley northwest of Daishaka, Osugi-mura, Minami-Tsugaru-gun, Aomori Prefecture. (IGPS loc. no. Ac-019)

The writer thanks Prof. Kotora Hatai of the Department of Geology, Faculty of Education, Tohoku University and Mr. Shizuo Mawatari of the Research Institute of Natural Resources, for their encouragements and kindness with regard to many important literatures, and to Mr. Kôichirô Masuda of the Department of Geology, Faculty of Education, Tohoku University for his kind offer of his collections.

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Notes on the Stratigraphy and Previous Work on the Fauna.

The stratigraphic position of the Daishaka formation as referred in this paper is shown in Table I. The forma-

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* Read June 20, 1956, before the 63rd Ordinary Meeting of Paleontological Society of Japan; received Mar. 27, 1957.

tions is unconfortable with both sub- and superjacent formations and is composed of coarse clastic sediments consisting of conglomerate and very coarse grained, greyish to light yellow sandstone, which is often cross-bedded and very fossiliferous.

The fossils of the formation include Foraminifera, Bryozoa, Brachiopoda, Mollusca, echinoides, sponge spicules, Cirripedia and calcareous algae. The Brachiopoda fauna from this formation were described by S. Nomura and K. Hatai (1935) and K. Hatai (1936, 1940), Mollusca by S. Nomura and K. Hatai (1935) and Foraminifera by K. Asano (1937, 1938). This is the first report on the Bryozoa.

Remarks on the Paleoecology of the Daishaka formation.

The Bryozoan species so far discriminated from the formation are given in Table II, in which the known Recent and fossil distributions are included.

Table I. Correlation Table of the Tertiary Deposits in the Hirosaki Basin and its Adjacent Districts.

	Ajigasawa district, Aomori Pref. Imanishi (1949)	West Part of Hirosaki Basin, Aomori Pref. Kanaya (1949)	East Part of Hirosaki Basin, Aomori Pref. Imaizumi (1957) (MS)	Oga Peninsula, Akita Pref.
Pleistocene	Yamadano formation			Katanishi formation
		Maedanome formation		
Pliocene		Takano dacite	Tsurugasaka tuff	Shibikawa formation
	Narusawa formation	Higashimeya formation	Daishaka formation	
		Sôma formation	Kogake formation Sabiishi	Wakimoto formation
Miocene	Maido formation		Matazawa formation Aboishi Aoni formation	Kitaura formation

The fauna is characterized by the following features :—

1) Specimens with *Membraniform* type zoarium predominate. These are characteristic of the littoral zone, generally encrusting on shells, stones, etc.

2) Specimens with *Cellariform* type of zoarium are not rare; these are also littoral forms and generally adhere to algae.

3) The fauna contains species commonly found in the Tsugaru Strait.

4) The number of species distributing to the Hawaiian Islands, Philippine Islands and Tsushima Strait are very few. The species with such wide spread records are considered to be cosmopolitan in distribution.

5) This fossil fauna is more closely related to the California (Santa Barbara and Santa Monica) Pleistocene fauna, which is very similar to the Recent fauna of the Queen Charlotte Islands of Canada, than to that of the Jizôdô formation (Pleistocene) of Chiba Prefec-

Table II. Geographic Distribution of Bryozoa from the Daishaka Formation, Aomori Prefecture.

Genus and Species	Frequency	Distribution																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Membranipora tuberculate Bosc	C	-	-	-	-	-	*	-	-	*	-	-	-	-	-	-	-	-	-	-
Mem. lacroxii Audouin	R	-	-	*	-	-	-	-	*	*	-	-	-	-	-	-	-	-	-	-
Mem. osburni Canu & Bassler	R	*	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-
Ellisina sp.	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conopeum barbarensis Gabb & Horn	R	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Antropora japonica (Canu & Bassler)	A	-	-	-	-	-	-	-	-	-	*	-	*	-	-	*	-	-	-	-
Ant. langucula (Canu & Bassler)	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
Ant. elongata Kataoka, n. sp.	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ant. daishakaensis Kataoka, n. sp.	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ant. hataii Kataoka, n. sp.	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hicksina sp.	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caulorhamphas porosus (Canu & Bassler)	R	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caul. disjunctus Canu & Bassler	R	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-
Cranosina sp.	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Callopora canui Silén	VA	-	-	-	-	*	-	-	-	-	*	-	-	-	-	-	*	-	-	-
Alderina hanzawai Kataoka, n. sp.	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crassimarginatela kumatae (Okada)	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	*	-	-
Crass. parviavicularia Kataoka, n. sp.	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rosseliana shibatai Sakakura	R	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-
Microporina articulata (Fabricius)	VA	-	-	-	*	-	-	-	-	-	*	-	*	*	*	-	-	-	-	-
Cellaria punctata (Busk)	C	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	*	*	*	-
Cellaria divarcata MacGillvray	R	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-
Figlaria ? ortmanni Silén	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-
Puellina innominata Couch	R	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-
Puellina heermani Gabb & Horn	R	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Puellina radiata Moll.	R	*	-	-	*	-	-	-	-	*	-	-	-	-	-	-	-	-	*	-
Cycliocolposa pertusa Canu & Bassler	R	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coleopora tsugaruensis Kataoka, n. sp.	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Col. tsugaruensis masudai K., n. subsp.	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petraliella asanoi Kataoka, n. sp.	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dakaria sp.	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hippodiplosia pertusa (Esper)	R	-	*	-	*	-	-	-	-	-	-	*	-	-	-	*	-	-	-	-
Schizomavella ovoidea Canu & Bassler	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-
Sch. cfr. *torquata* Canu & Bassler	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
Exochella sp.	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Genus and Species	Frequency	Distribution																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Microporella cfr. *californica* Hincks	R	-	-	-	-	*	*	-	-	-	-	-	-	*	-	-	-	-	-	-
Mic. cfr. *ciliata* Linnaeus	R	-	-	-	-	-	-	-	-	*	-	*	-	*	-	-	-	-	-	-
Porella purprea Jullien	R	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	*	-
Porella kurilensis Mawatari	C	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-
Rhamphostomella sollers Canu & Bassler	R	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-
Rymulostoma ? sp.	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Smittina porifera (Hincks)	R	-	-	-	*	-	*	-	-	-	-	-	-	*	-	*	-	-	-	-
Sm. areolata Canu & Bassler	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-
Parasmittina trispinosa (Johnston)	C	-	-	*	-	-	-	-	*	*	*	*	*	*	*	-	-	-	-	-
P. trispinosa applicata (Canu & Bassler)	R	-	-	-	-	-	-	-	-	-	*	*	-	-	-	-	-	-	-	-
P. trispinosa nitida (Hincks)	R	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P. trisp. aomoriensis Kataoka, n. subsp.	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Perigastrella spinossima major (Hincks)	R	-	-	-	-	-	*	-	-	-	-	-	-	*	-	-	-	-	-	-
Holoporella cfr. *serratirostris* MacGillvray	R	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	*
Myriozoum subgracile d'Orbigny	VA	-	-	-	-	-	-	-	-	-	*	-	-	*	*	-	-	-	-	-
Lichenopora radiata Savigny & Audouin	C	-	-	-	*	-	-	-	-	*	*	-	-	-	-	-	*	-	-	-
Lichenopora buski Harmer	R	-	-	-	*	-	-	-	-	-	*	-	-	-	-	*	*	-	-	-
Actinopora japonica Canu & Bassler	C	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-
Berenicea sarniensis (Norman)	A	-	-	-	*	-	-	*	-	*	*	-	-	*	-	-	*	-	-	-

VA:—Very abundant, more than 20 specimens, A:—Abundant, more than 10 specimens, C:—Common, more than 5 specimens, R:—Rare, less than 4 specimens.

Locality number ;—(1) Jamaica (Miocene), (2) Panama Canal Zone (Pliocene), (3) South Carolina (Pliocene), North America.

4—8. Pleistocene ;—(4) Jizôdô formation, Bôsô Peninsula, Chiba Prefecture, Japan, (5) Santa Barbara, California, (6) Santa Monica, California, (7) Panama Canal Zone, (8) South Carolina.

9—19. Recent ;—(9) Cosmopolitan, (10) Tsugaru Strait, (11) Mutsu Bay, (12) Kurile Islands to Northeast Hokkaido, (13) Queen Charlotte Islands, Pacific Coast of Canada, (14) Arctic Region, (15) Toyama Bay, Sea of Japan, (16) Kii and Izu Peninsulas, (17) Tsushima Strait, (18) Philippine Islands, (19) Hawaiian Islands.

ture. Unfortunately there are no known Neogene bryozoan faunas from the Pacific borderland, thus comparison could not be made.

6) The abundant species of the present fauna are commonly found in the cold water fauna from the Kurile Islands.

7) The known bathymetric distribution of the Bryozoa occurring in the Daishaka formation is given in Table III, from which it may be inferred that the bathymetric distribution of the fos-

Table III. Bathymetric Distribution of the Identified Bryozoa Fossils.

Specific Name	Range in Depth (in meters)
Antropora langucula (Canu and Bassler)	58–102 (Philippines)
Callipora canui Silén	100–600
Crassimarginatella kumatae (Okada)	97–100
Figlaria ? ortmanni Silen	100–600 (Sagami Bay, Japan)
Microporina articulata (Fabricius)	66–123
Cellaria punctata (Busk)	18–120
Holloporella serratirostris MacGillvray	36– 90
Parasmittina trispinosa (Johnston)	100 (Toyama Bay, Japan)
Smittina porifera (Hincks)	34–150
Microporella ciliata (Linnaeus)	25 (Onagawa Bay, Japan) 110 (Tsugaru Strait, Japan)
Lichenopora radiata Savigny & Audouin	54–144
Lichenopora buski Harmer	54–144

sils is shallower than 100 m.

From the forgoing characters, it may be inferred that the Bryozoan fauna of the Daishaka formation is typically northern in aspect and of shallow water origin. The fauna seems to correspond to one influenced by the Oyashio Current, probably such as now living off the coast of eastern Hokkaido to Kurile Islands.

The shallow water condition in which the fauna lived corresponds well with the lithologic characters of the Daishaka sediments, which consist of coarse clastics quite free from argillaceous materials.

The above-stated views agree, in general, with the results obtained by S. Nomura and K. Hatai (1936, 1940) from their studies on the molluscan fauna. With regard to the thermal condition which governed the bryozoan fauna, the writer is in the opinion that may have been more or less similar to the southern coast of Hokkaido or slightly cooler than the seas adjacent to the western and northern parts of Aomori Prefecture. This view is also in good agreement with that obtained by K. Asano, S. Nomura and K. Hatai.

The bryozoan fauna of the Daishaka formation shows similarity with the fossil fauna of the northwestern coast of America particularly to the Pleistocene of Santa Barbara and Santa Monica in California and the Recent fauna of Canada. The above-stated fact coincides with the evidence afforded by the foraminiferal fauna, that is, K. Asano (1938) stated that the Pilocene foraminiferal fauna of the Japan Sea Province shows affinity with the fauna of the Pliocene and Pleistocene of the west coast of North America.

Description of New Species

Family Hicksinidae Canu and Bassler, 1927

Genus *Antropora* Norman, 1903

Antropora elongata Kataoka, n. sp.

Plate 22, Figure 8.

The zoarium encrusts shell fragments. The zooecia distinct, separated by thin and sharp ridge of mural rim, subrectangular in form, much elongated in outer zooecia (distalward). The opesia is elliptical or oval. There are a pair of small avicularium with raised rim around its orifice placed in distal corner of zooecium. The proximal cryptocyst developed in later zooecia; olocystal fine and granulated. The ovicell not present.

Dimensions:—

Zooecia	Opesia
Lz=1.0-0.8 mm.	ho=0.5 mm.
lz =0.34-0.33 mm.	lo =0.3-0.32 mm.

Remarks:—This species resembles *Membranipora lacroxii* Audouin (1826), but differs from it in the presence of distal avicularia and by not having tubercles. *Antropora langucula* (Canu and Bassler) (1929), differs from this species in its dimensions and by the presence of raised rim of avicularia.

Cotype:—IGPS. coll. cat. no. 77394.

Antropora daishakaensis Kataoka, n. sp.

Plate 22, Figure 7.

The zoarium encrusts shell fragments. The zooecia distinct and contact through mural rim with surrounding zooecia, its form oblong oval. The mural rim is smooth and the greater part occupied by avicularia and ovicell. There are three avicularia in each zooecia, two of which are at distal corner of zooecia, their form is small fusiform, and beak is directed towards the zooecial axis; the other avicularium large and placed at proximal part of zooecia along the mural rim, hooked-form, like *Callopora canui* Silen, 1941. The opesium occupies almost whole zooecia, oval. The ovicell is hyperstomial and ornamented with transversal ribs.

Dimensions:—

Zooecia	Opesia
Lz=0.63 mm.	ho=0.3-0.5 mm.
lz=0.2-0.5 mm.	lo=0.2 mm.

Remarks:—The present specimens differ from *Antropora japonica* (Canu and Bassler) (1929), by the presence of proximal avicularium of large form and little elongated zooecial form, and also from *Callopora canui* Silen (1941) by the presence of distal avicularia at the corner of zooecia.

Holotype:—IGPS. coll. cat. no. 77395.

Antropora hataii Kataoka, n. sp.

Plate 22, Figure 4.

The zoarium encrusts pectinid shell fragments. The zooecia distinct, adjacent through mural rim, elongated suboblong. Mural rim in distal part of zooecia, hyperstomial ovicell, little raised, rectangular, finely granulated, olocystal anterior, with transversal slit. The opesia is generally oval but sometimes fusiform by depression of surrounding zooecia. The gymnocyst is small in proximal part of zooecia. The two small fusiform avicularia placed at distral part of mural rim, and its beak is directed towards the zooecial axes.

Dimensions:—

Zooecia	Opesia
Lz=0.8-0.9 mm.	lo=0.5-0.8 mm.
lz=0.4-0.5 mm.	wo=0.3 mm.

Remarks:—This new species resembles *Antropora lowei* (Canu and Bassler) (1920), but differs from it by it measurements and form of ovicell. *Antropora langucula* (Canu and Bassler) (1929) differs from this species by the presence of zooecial furrow and ornamentation of the ovicell surface. *Antropora elongata* Kataoka n. sp. differs from this species by its much elongated zooecial form and broad gymnocyst. This new species also differs from *Antropora langucula* (Canu and Bassler) (1929), by the presence of a slit on the anterior part of the ovicell.

Cotype:—IGPS. coll. cat. no. 77376.

Family Calloporidae Norman, 1903

Genus *Alderina* Norman, 1903

Alderina hanzawai Kataoka, n. sp.

Plate 22, Figure 1.

The zoarium encrusts molluscan shell fragments. The zooecia are distinct, separated by deep furrows, sub-elliptical mural rim well developed and strong, elevated, no trace of spine, little crenulated. The opesia is oval. The ovicell is hyperstomial and placed on the convex olocystal gymnocyst of distal zooecium. The form of the ovicell is semiglobular and its frontal is olocystal. The orifice of ovicell opens upon the distal end of opesia.

Dimensions:—

Zooecia	Opesia
Lz=0.6 mm.	ho=0.4 mm.
lz=0.3–0.4 mm.	lo=0.2–0.3 mm.

Ovicell
lov=0.2–0.25 mm.
wov=0.3–0.2 mm.

Remarks:—This new species is referred to the named genus by the absence of embedded ovicell and interzooecial tuberosity. The characters distinguishing this species from the others of the genus *Alderina* are mentioned in the description.

Holotype:—IGPS. coll. cat. no. 77397.

Genus *Crassimarginatella* Canu, 1900

Crassimarginatella parviavicularia Kataoka, n. sp.

Plate 22, Figure 2.

The zoarium encrusts molluscan fragments. The zooecia distinct, separated by deep furrows between mural rims, subcircular or elliptical. The mural rim salient, sharp, finely granulated, olocystal, gymnocyst present in some zooecia. The interzooecial avicularium is a little smaller than the ordinary zooecia and elliptical, with trace of pivot, mural rim of avicularia elevated from zooecial gymnocyst and separated from surrounding zooecia by shallow furrows. The ovicell hyperstomial, small and globular, placed on the gymnocyst of distal zooecia and elevated from mural rim, its surface olocystal.

Dimensions:—

Zooecia	Opesia
Lz=0.4–0.5 mm.	Lo=0.2–0.3 mm.
lz=0.3 mm.	lo=0.18–0.2 mm.
Avicularia	Ovicell
Lav=0.1 mm.	Lov=0.18 mm.
	lov=0.2 mm.

Remarks:—This species differs from *Crassimarginatella crassimarginata* (Hincks) (1880), by the smaller micrometric measurements and smaller interzooecial avicularia. *Crassimarginatella pusilla* (Canu and Bassler) (1920), differs from this species by the larger micrometric maesurement and form of its ovicell.

Cotype:—IGPS. coll. cat. no. 77398.

Family Petraliidae Levinsen, 1909

Genus *Coleopora* Canu & Bassler, 1927

Coleopora tsugaruensis Kataoka, n. sp.

Plate 22, Figure 6.

The zoarium encrusts pectinid shell fragments. The zooecia distinct, separated by a furrow, oval (little elongated). The peristome well developed, peristomice subrectangular, trace of spine present on peristome (about 6). The aperture embedded in the peristomice, semicircular. The ovicell embedded in the distal zooecia and its front rising up from ordinal zooecial front, globose. The frontal convex tremocystal, avicularia and vibracula not present.

Dimensions :—

Zooecia	Peristomice
Lz=0.3-0.6 mm.	wper=0.12 mm.
lz=0.35 mm.	lper=0.1 mm.

Remarks :—CANU and BASSLER (1929) pointed out that this genus is a shallow water type. At Daishaka *Coleopora tsugaruensis* KATAOKA, n. sp. and *Coleopora tsugaruensis masudai* KATAOKA, n. subsp. are very abundant. This fact shows that this fossil fauna lived in a shallow water condition.

Cotype :—IGPS. coll. cat. no. 77399.

Coleopora tsugaruensis masudai KATAOKA, n. subsp.

Plate 22, Figure 3.

The zoarium encrusts pectinid shell fragments. The zooecia distinct, separated by a furrow, which is larger and more widely oval compared with the species. The frontal tremocystal, convex, dimensions of each zooecia variable. The aperture embedded in the peristomice, semicircular. Peristomice especially on proximal part, elongated. Mural spine (4-6 ?) present on the side of peristomice. The ovicells embedded in distal zooecia, never closed by operculum, its frontal tremocystal, and rising from distal zooecia, globose. The avicularia and the vibracula not present.

Dimensions :—

Zooecia	Peristomice
Lz=0.5-0.7 mm.	hper=0.1 mm.
lz=0.84-0.33 mm.	lp=0.1-0.13 mm.

Remarks :—This subspecies shows a wider range of variation than *Coleopora tsugaruensis* KATAOKA, n. sp. in the dimensions, form of zooecia, and presence of expansion of proximal side of peristomice, but agrees in all other characters with the species. For such reasons the author distinguishes the present specimens from the species. The species shows stable characters contrary to the instable ones of the subspecies. This feature is thought to have bearing on the evolution of this group.

Holotype :—IGPS. coll. cat. no. 77400.

Genus *Petraliella* CANU & BASSLER, 1927

Petraliella asanoi KATAOKA, n. sp.

Plate 22, Figure 5.

The zoarium encrusts pectinid shell fragments. The zooecia distinct, separated by furrow which is deep in curved zooecial front and shallow in flat zooecial front. The form of zooecia is subhexagonal, its length shorter than the width. The frontal is tremocystal. The aperture is semilunar, two lyrula developed and placed in the proximal corner of aperture except in some zooecia. The direction of avicularian beak obliquely crosses the axes of zooecial developement in almost all zooecia, but in a few zooecia it (direction of avicularian beaks) crosses transversally the axes. The ovicell absent. Swollen peristomice is very characteristic.

Dimensions :—

Zooecia	Aperture
Lz=0.45-0.5 mm.	wa=0.2-0.17 mm.
lz=0.35-0.4 mm.	la=0.1 mm.

Avicularia
lav=0.1 mm.
wav=0.07–0.05 mm.

Remarks:—This species is very characteristic in its swollen peristomice as above described and is thus easily distinguished from the known species of this genus (*Petraliella*).

Cotype:—IGPS. coll. cat. no. 77401.

Family Exochella Bassler, 1935

Genus *Exochella* Jullien, 1888

Exochella sp. indet.

Plate 22, Figure 10.

The zoarium encrusts pectind shell fragments. The zooecia distinct, separated by salient furrow, elliptical and with projection of avicularia area, zooecia serial in arrangement. The frontal is convex and olocystal with eight to eleven marginal areolar pores. The aperture is circular or subcircular with proximal pores, lyrula and condyle not present. The avicularia occur in a side of zooecia transversal. The ovicell absent in the specimens.

Dimensions:—

Zooecia	Aperture
Lz=0.31–0.38 mm.	la=0.06 mm.
lz=0.19–0.25 mm.	ha=0.06–0.05 mm.

Remarks:—The general structure of the specimens is like *Exochella longistris* Jullien 1888, but differs from it by the dimensions of zooecia and the form of aperture.

Family Mucronellidae Levinsen, 1902

Genus *Parasmittina* Osburn, 1952

Parasmittina trispinosa (Johnston) *aomoriensis* Kataoka, n. subsp.

Plate 22, Figure 9.

Compare with:
1929 Canu and Basseler, *U.S. Nat. Mus., Bull. 100, vol. 9*, p. 340.

Description:—The zoarium encrusts a shell fragment. The zooecia distinct, separated by salient furrow, oblong rectangluar and sometimes fusiform or irregular in form. The frontal almost flat, pleurocyst finely granulated, areolar pores placed in marginal part of zooecia. The aperture orbicular, and lyrula is narrow, two distal spines are present in some zooecia. The avicularia obliquely crossing axes of zooecia, and slender. The ovicell present in some zooecia but broken in others, hyperstomial. The peristomice developed especially in proximal part.

Dimensions:—

Zooecia	Peristomice
Lz=0.6 mm.	lp=0.075–0.1 mm.
lz=0.25–0.31 mm.	hp=0.12–0.13 mm.

Remarks:—The obliquely directed beak of avicularia is characteristic of this variety. In the Daishaka formation, this species and its varieties are very abundant. Canu and Bassler, pointed out that the ascendant avicularia of *Parasmittina trispinosa* are more abundant in the northern seas while the descendant avicularia occur more frequently in the equatorial seas and that the typical form is frequent in the temperate zone. The common occurrence of the species and its varieties indicate that the Daishaka formation was deposited under a condition typical of the northern temperate zone.

Holotype:—IGPS. coll. cat. no. 77402.

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NOMURA, S. and K. HATAI (1935), Pliocene

Explanation of Plate 22

(All enlarged 30 times)

Fig. 1. *Alderina hanzawai* KATAOKA, n. sp. Holotype, IGPS.* coll. cat. no. 77397. A portion of zoarium with ovicelled zooecia.

Fig. 2. *Crassimarginatella parviavicularia* KATAOKA, n. sp. Cotype, IGPS. coll. cat. no. 77398. Unilamellar zoarium with interzooecial avicularia.

Fig. 3. *Coleopora tsugaruensis masudai* KATAOKA, n. subsp. Holotype, IGPS. coll. cat. no. 77400. A portion of zoarium, showing the variation of zooecial form.

Fig. 4. *Antropora hataii* KATAOKA, n. sp. Cotype, IGPS, coll. cat. no. 77396. A portion of zoarium, showing the ovicells with transversal slit.

Fig. 5. *Petraliella asanoi* KATAOKA, n. sp. Cotype, IGPS. coll. cat. no. 77401. A portion of zoarium.

Fig. 6. *Coleopora tsugaruensis* KATAOKA, n. sp. Cotype, IGPS. coll. cat. no. 77399. A portion of zoarium.

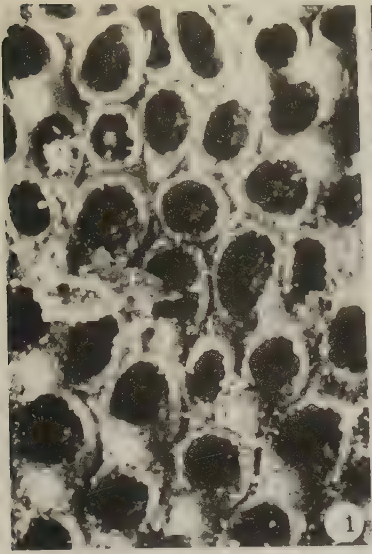
Fig. 7. *Antropora daishakaensis* KATAOKA, n. sp. Holotype, IGPS. coll. cat. no. 77395. A portion of ovicelled zoarium.

Fig. 8. *Antropora elongata* KATAOKA, n. sp. Cotype, IGPS. coll. cat. no. 77394. A portion of zoarium, showing curved zooecia.

Fig. 9. *Parasmittina trispinosa aomoriensis* KATAOKA, n. subsp. Holotype, IGPS. coll. cat. no. 77402. A portion of zoarium, showing obliquely directed avicularia.

Fig. 10. *Exochella* sp. indet. A portion of zoarium.

* IGPS=abbrevation for Institute of Geology and Paleontology, Tohoku University, Sendai.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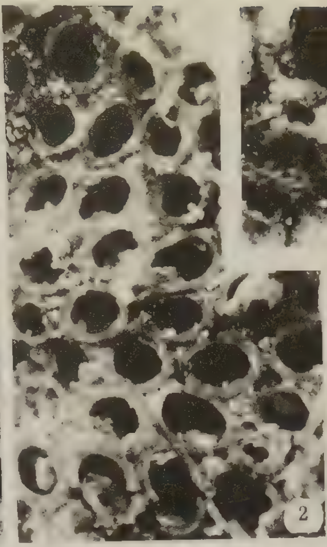
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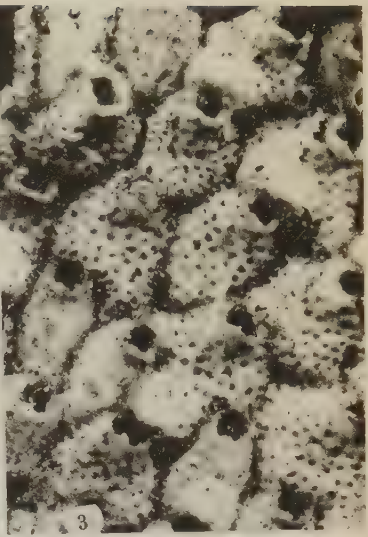
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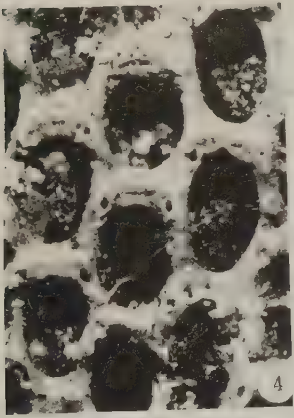
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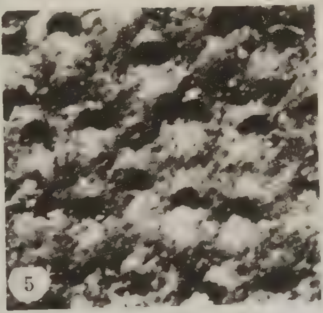
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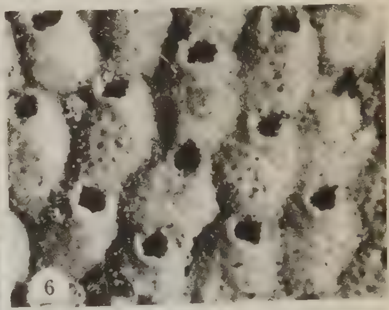
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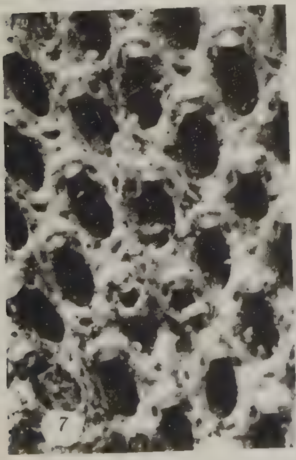
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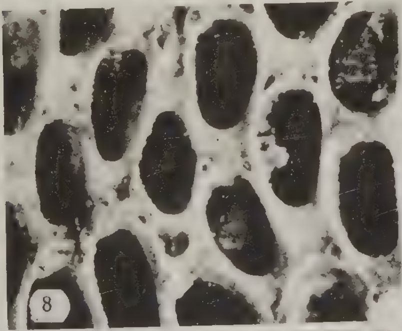
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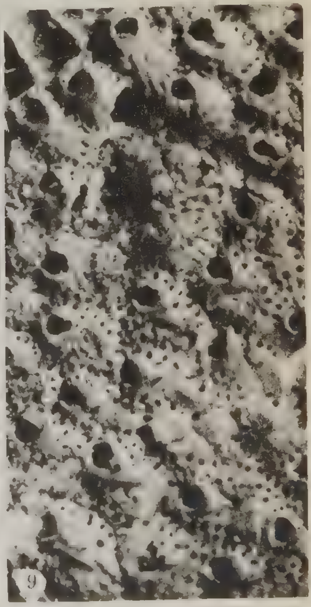
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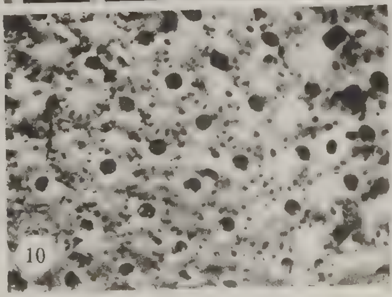
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